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INTERSTATE ELECTRONICS CORPORATION
A Figgie International Company
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TITLE

PERFORMANCE SPECIFICATION
INTEGRATED RECEIVER

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
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1.0 SCOPE

1.1 General

This specification defines the performance, design, development, interface, and test requirements for the Integrated Receiver (IR) Interstate Electronics Corporation (IEC) Part Number 7472100, herein also referred to as the unit.

1.2 Purpose

The unit will be used in the Second TDRSS Ground Terminal (STGT) User Service Subsystem (USS) to provide data recovery and tracking for return services. The Tracking and Data Relay Satellite System (TDRSS) is a major segment of NASA's Space Network.

2.0 APPLICABLE DOCUMENTS

The following documents of the exact date of issue, unless otherwise noted, form a part of this specification to the extent specified herein. The order of precedence of this specification relative to the referenced documents shall be as established in 3.8.

2.1 GOVERNMENT DOCUMENTS

2.1.1 Specifications

2.1.1.1 Federal - None.

2.1.1.2 Military

MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys, Revision D, 28 February 1989
MIL-C-39019	Magnetic Low-Power, Sealed, Trip-Free, Circuit Breakers, General Specifications for Supplement 1, July 1974
MIL-P-53030	Primer Coating, Epoxy, Water Reducible, Lead Chromate Free December 1983
MIL-P-55110	Printed Wiring Boards, General Specification for Revision D, December 1984
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems, Revision D, 30 November 1989

2.1.1.3 National Aeronautics and Space Administration (NASA) - None.

2.1.2 Standards

2.1.2.1 Federal

FED-STD-595	Federal Standard Colors - Paint Revision A, through Notice 9 May 1985

2.1.2.2 Military

MIL-STD-130	Identification Marking of U.S. Military Property Revision G, 11 Oct 88
MIL-STD-454	General Requirements for Electronic Equipment Revision K, Notice 3, 26 February 1987
MIL-STD-461	Electronic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, Part 3 Revision C, August 1986

MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of. Through Notice 1, February 1971
MIL-STD-975	NASA Standard Electrical, Electronic, & Electromechanical (EEE) Parts List Revision H, 30 June 1989
MIL-STD-1130	Connections, Electrical, Solderless, Wrapped Revision B, December 1978
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities Revision D, 14 March 1989
MIL-STD-1553B	Digital Time Division Command/Response Multiplex Data Bus. Notice 2, 08 September 1986

2.1.2.3 NASA

STDN No. 101.2	Space Networks Users' Guide. GSFC. Revision 6, September 1988.
STDN No. 108	PN Codes for Use with the Tracking and Data Relay Satellite System (TDRSS). December 1976
STDN No. 270.7	GSFC Grounding System Requirements July 1989
STDN No. 927.1	STGT Configuration Management Plan March 1987
STDN No. 927.2	STGT Performance Verification Plan May 1987
STDN No. 927.4	STGT Quality Assurance Plan May 1987

2.1.3 Drawings

2.1.4 Other Publications

IRIG-STD 104-70	IRIG Standard Serial Binary Code Formats August 1970
MIL-HDBK-217	Reliability Prediction of Electronic Equipment, Notice 1, 2 January 1990
NHB 6000.1C	Requirements for Packaging, Handling, and Transportation, June 76
FCC R&R	FCC Rules and Regulations, Part 15 Subpart J for Microprocessor Controlled Devices No date given.

2.2 NON-GOVERNMENT DOCUMENTS

2.2.1 Specifications

2.2.1.1 Interstate Electronics Corporation

2.2.1.2 General Electric Corporation/Aerospace

GES-STGT-1323	SSA Equipment HWCI Specification (HWCI No. 5). (aka STGT-HE-04-5) Revision 2, September 1990 Reference Correspondence C901-1289 dated 8 March 1991
GES-STGT-1325	KSA Low Data Rate Equipment HWCI Specification (HWCI No. 7). (aka STGT-HE-04-07) Revision 2, September 1990 Reference Correspondence C901-1289 dated 8 March 1991
GES-STGT-1328	Multiple Access Receiver/Transmitter HWCI Specification (HWCI No. 10). (aka STGT-HE-04-10) Revision 2, September 1990 Reference Correspondence C901-1289 dated 8 March 1991
STGT-HE-06-2	GE Hardware/Hardware Interface Control Document for STGT Appendix F Interface Control Document for Integrated Receiver - Subsystem Controller/USS ADPE Status and Control 1553B Interface November 1990 through DCN 002

2.2.2 Standards

2.2.3 Drawings

2.2.3.1 Interstate Electronics Corporation

7472102	Drawing Tree Integrated Receiver Assembly. 23 October 1989
C901E3860	STGT Unit Test Matrices

2.2.4 Other Publications

NFPA 70	National Electric Code (NEC), 1987

2.2.4.1 General Electric Corporation

SOW-GE-STGT-8701	Statement of Work (SOW) for USS Equipment SSA Equipment HWCI KSAR Low Data Rate Equipment HWCI MA RCVR/XMTR Equipment HWCI. Latest Revision of November 1989

2.2.4.2 Interstate Electronics Corporation

C901E3331	Configuration Management Plan and Procedures for Second TDRSS Ground Terminal. Contract No. F14000-U16507, SDRL Items CM-01 and CM-02. December 1989
C901-812	Supporting Engineering Analysis Data for Second TDRSS Ground Terminal. Contract No. F14-16507, SDRL No. HE-08. April 1990
C903F3379	Training and Training Equipment Plan SDRL LO-02, October 1990

3.0 REQUIREMENTS

3.1 PRIME ITEM DEFINITION

The Integrated Receiver (IR) is an integral part of the STGT user Service Subsystem (USS). The unit provides data recovery and tracking data for all S-Band Single Access (SSA) and Multiple Access (MA) return user services. For K-Band Single Access (KSA) Return Services, the unit provides tracking data for all services, including K-Shuttle. The unit provides autotrack error signal detection for all KSA services, except K-Shuttle Mode 2. The unit provides data recovery for all Low Data Rate KSA return services.

The unit shall provide the following essential functions as required, and where applicable:

a. Provide doppler correction, including the capability to:

   (1) Receive doppler updates (ephemeris data) from the data bus.

   (2) Maintain a Forward Model of the doppler compensation and control performed on the forward link.

b. Despread and track the received PN spread signal.

c. Recover PN code epoch and clock and perform range measurements and time transfer measurements. For MA services, provide PN code and lock status as output signals.

d. Demodulate the carrier.

e. Recover carrier and perform doppler measurement, including the S-Shuttle case where the return signal is carrier only (no modulation). This includes all USS Return Services except K-Shuttle Mode 2 (frequency modulation mode).

f. Recover symbol clock and detect symbols, including single and dual channel configurations for all USS Return Services, except KSA High Data Rate.

g. Support Data Delay Measurement.

h. Perform ground terminal delay measurement for Range Zero Set.

i. Resolve data channel and phase ambiguity.

j. Provide deinterleaving and convolutional decoding, including S-Shuttle unique rate 1/3 decoding. Provide the capability to bypass the decoders.

k. Provide format conversion of recovered symbols and data so that the output data stream is NRZ-L.

l. Provide as outputs the recovered data streams with synchronous data clocks, with the following exceptions:

   (1) Clamp the data output (I and Q independently) to a Logical-1 when there is detected loss of data in the channel.

   (2) During times when a data channel is clamped to a Logical-1 due to a loss of data in the channel, maintain the data clock output signal.

m. For K-Band Single Access (KSA) return services, including K-Shuttle Mode 1, provide carrier recovery for doppler measurements and perform autotrack error signal detection. Autotrack error signal detection is not available for K-Shuttle Mode 2 (frequency modulation mode).

n. For K-Band Shuttle Mode 1 (quadrature double sideband mode), perform extraction, acquisition, and demodulation of the subcarrier from the 370 MHz IF Input. For KSHR Mode 2, provide data and carrier recovery on the Shuttle subcarrier provided to the unit on the 8.5 MHz IF Input.

o. For S-Band Single Access (SSA) return services, including S-Shuttle, provide for SSA Combining.

p. Generate status data, including self-test and fault isolation information. Provide required status data (including Eb/No measurements, channel error rates, and channel lock times) to both the front panel and to the data bus. Additional status data may be provided to the data bus that is not available on the front panel.

q. Communicate with the Primary Interface via a MIL-STD-1553B data bus.

r. To support maintenance and operation, provide front panel and maintenance panel controls, indicators, and test points.

3.1.1 Prime Item Diagrams
Figure 1 is a functional diagram of an S-Band Single Access Return (SSAR) service chain. Figure 2 illustrates the functional relationship between the Integrated Receiver and the rest of the service chain. Similarly, figures 3, 4, 5, and 6 illustrate functional diagrams of the K-Band Single Access Return (KSAR) and the Multiple Access Return (MAR) service chains and their relationships with the Integrated Receiver. Figure 7 shows a block diagram of the unit with major components identified. The unit front panel is shown in figure 8. The maintenance panel is shown in figure 9, while figure 10 depicts the unit back panel.

3.1.2 Interface Definition
Consistent with the criteria for configuration item identification in STDN No. 927.1, (section 2.3.2), the Integrated Receiver will be treated as a single configuration item and may be used interchangeably in the SSA Equipment, KSA Low Data Rate Equipment, or MA Receiver/Transmitter hardware configuration items (HWCI). The unit has three interfaces; (1) a back panel interface, (2) a front panel interface, and (3) a maintenance panel interface.

a. Connectors and signals - Tables I, II and III show the connector termination and signal identification for the unit's interfaces. Table IV provides further identification of connector types.

b. Functional and Physical Interfaces - The primary control and interface with the unit is via the back panel interface. Secondary, but limited, control is provided on the front panel and maintenance panel interfaces. The back panel interface will be called the Primary Interface. Note that the unit's interfaces all begin and end at the unit. That is, no cables or power cords are provided with the unit.

c. Primary Interface - On one side of the Primary Interface is the Integrated Receiver provided by Interstate Electronics Corporation. On the other side are all other configuration items (such as Subsystem Controller, Baseband Switch, etc.) which are controlled by General Electric.

d. KSA units - Although all Integrated Receivers may be configured as KSA units, only KSA units require autotrack and high data rate carrier recovery functions. These functions are provided as a separate kit which is required for KSA units, but which is optional for units used in the SSA and MA HWCIs. See 3.1.3 Major Components List.

3.1.2.1 Primary AC Power - Power will be provided to the unit from the Primary Interface. The input Primary AC Power will possess the signal characteristics and unit interface requirements described in table V.

3.1.2.2 MIL-STD-1553B Data Bus - The unit shall communicate with the Primary Interface via a MIL-STD-1553B Digital Time Division Command/Response Multiplex Data Bus, herein also called the data bus. The unit shall be configured as a remote terminal on the data bus. The associated Primary Interface will provide the bus controller. The unit shall meet the interface requirements of STGT-HE-06-02, Appendix F. A list of messages and a description of characteristics is given below:

a. Data bus commands - Messages from the Primary Interface bus controller to the IR remote terminal are called commands. They are:

(1) IR_SET_STATE_COMMAND
(2) IR_SPECIFIC_CONFIGURATION_COMMAND
(3) IR_COMMON_CONFIGURATION_COMMAND
(4) IR_DOWNLOAD_COMMAND
(5) IR_EPHEMERIS_DATA_COMMAND
(6) IR_BURN_ALERT_COMMAND
(7) IR_EXPAND_FREQ_SEARCH_WINDOW_COMMAND
(8) IR_START_ACQUISITION_COMMAND
(9) IR_ZERO_DOPPLER_COUNT_COMMAND
(10) IR_FWD_FREQUENCY_SWEEP_COMMAND
(11) IR_FWD_BREAK_LOCK_COMMAND
(12) IR_FWD_DOPPLER_COMP_CONTROL_COMMAND
(13) IR_START_FORWARD_MODEL_COMMAND
(14) IR_COLD_START_COMMAND

b. Data bus reports - Messages from the IR remote terminal to the Primary Interface bus controller are called status reports. They are:

(1) IR_SPECIFIC_CONFIGURATION_REPORT
(2) IR_COMMON_CONFIGURATION_REPORT
(3) IR_TRACKING_REPORT
(4) IR_EXTENDED_BIT_REPORT
(5) IR_PERFORMANCE_REPORT

c. Remote terminal address - See tables I and VI.

d. Redundant bus support - The unit provides a single MIL-STD-1553B data bus with redundant inputs.

e. Data bus rules - Additional rules and details of data bus operation are contained in STGT-HE-06-02.

f. Signal characteristics and unit interface - See table VI.

3.1.2.2.1 Data Bus Commanding - In addition to the descriptions of data bus commands, and data bus rules, provided in STGT-HE-06-02, the following requirements apply to commanding the unit. Commands may also originate from the front panel, when specified.

3.1.2.2.1.1 Synchronous Commands - Execution of synchronous commands shall be initiated by the IR at the 1 pps mark in the time field of the command (1 pps mark and CTFS 1 PPS epoch are synonymous). For this requirement, execution time is measured from the effective time. For commands that are to be completed and latched at the 1 pps mark, the execution time is specified as zero. The unit shall perform all necessary setup within the limits specified below.

a. Setup time - Setup time shall be less than or equal to 1 second for all synchronous commands. Setup time is defined as the maximum time required to prepare for execution of a synchronous command.

b. Single command execution - The unit shall be capable of executing one synchronous command per effective time. Any subsequent command shall take precedence, and cancel the previous command.

c. Command execution - The unit shall complete any necessary setup and execute the command within the time specified in table VII.

3.1.2.2.1.2 Asynchronous Commands - Asynchronous commands are defined as commands which do not require an effective time. These commands shall be executed within the limits specified in table VII, where execution time is measured from the receipt of the command at the unit.

a. Individual command rate - The unit shall support a command rate for any asynchronous command defined as one per execution time. The unit may overwrite the previous command of the same type.

b. Command rate - The unit shall be capable of processing a minimum of four asynchronous commands sent to the unit within any one second period.

3.1.2.2.2 Operating States - With respect to logical commanding, and logical operation, the unit shall possess the operating states listed in table VIII. These states are described below.

a. CONFIDENCE TEST IN PROGRESS - This state shall be entered upon power up or reset of the unit as defined in 3.2.1.6.1

b. EXTENDED BIT - This state shall be entered by the receipt of an IR_EXTENDED_BIT_COMMAND from either the front panel or from the data bus. The unit shall exit this state either upon completion of the built-in tests (BIT) or by termination of BIT by either a front panel command or by data bus command. Additional Extended BIT requirements are given in 3.2.1.6.1.2.2 Extended BIT.

c. STANDBY - The unit shall enter this state upon completion of the Confidence Test, or by data bus command. Upon receipt of the IR_SPECIFIC_CONFIGURATION_COMMAND, the unit shall start configuration of the unit.

d. CONFIGURATION IN PROGRESS - This state is a transition state and indicates that unit configuration is in progress. After the unit receives the IR_SPECIFIC_CONFIGURATION_COMMAND, the transition from STANDBY to CONFIGURED shall be complete in less than one second.

e. CONFIGURED - This state shall indicate that the IR is configured to start acquisition.

f. ACQUISITION - This state shall indicate that the IR is performing signal acquisition (that is code and carrier acquisition).

g. TRACK - This state shall indicate that the IR has achieved lock and is tracking the signal as configured. The unit shall remain in this state until either loss of lock, or until a state change is commanded.

h. REACQUISITION - This state shall indicate that the IR is attempting to reacquire the signal in response to a loss of lock indication.

3.1.2.2.3 Forward Model - The IR_COMMON_CONFIGURATION_COMMAND will be effective at least one second prior to the effective time of the IR_START_FORWARD_MODEL_COMMAND. No ephemeris data shall be required to start the Forward Model. For coherent services, the Forward Model will be sent prior to the receipt of the IR_START_ ACQUISITION_COMMAND. Receipt of a new IR_START_FORWARD_MODEL_COMMAND or an IR_COLD_START_COMMAND shall cause the Forward Model to restart and synchronize with the CTFS 1 PPS epoch.

3.1.2.2.4 Cold Start - The unit shall support the IR_COLD_START_COMMAND. This command permits the unit to receive the necessary data to synchronize the Forward Model with a previously started Modulator/Doppler Predictor (MDP). Upon receipt of the command, the unit's Forward Model shall synchronize its PN code state and carrier frequency with that of the subject MDP, given the following:

a. MDP configuration - The IR will be provided with an IR_COMMON_CONFIGURATION_COMMAND matching (i.e., common with) the configuration of the MDP prior to the receipt of the IR_COLD_START_COMMAND.

b. MDP snapshot status - As parameters of the IR_COLD_START_ COMMAND, the unit will be provided with status of the MDP's PN code state and carrier frequency at a prior CTFS 1 PPS epoch time, called the SNAPSHOT TIME.

c. Starting time - The IR shall propagate the MDP state to a future starting time, called the EFFECTIVE TIME, which is also provided in the IR_COLD_START_COMMAND. The command will arrive at least one second prior to the EFFECTIVE TIME. The time difference between the SNAPSHOT TIME and the EFFECTIVE TIME will be less than 20 seconds. No MDP control commands will be in effect during the interval from the SNAPSHOT TIME to the EFFECTIVE TIME.

d. Transparency - After the EFFECTIVE TIME, all the same requirements apply to the cold-started IR as if the unit had been initialized at the same time as the associated MDP.

3.1.2.2.5 Command Memory - The IR shall provide sufficient memory capability for the IR_SPECIFIC_CONFIGURATION_COMMAND and for the IR_COMMON_CONFIGURATION_COMMAND to allow a null command to be sent to transition from one state to the next, provided the applicable data were supplied during a previous command transmission. The IR shall use the data from this last transmission to perform any necessary configurations. If a required parameter is not provided upon change or service type, but was previously down loaded while the unit was in the present CONFIGURED state, the IR shall use the previously supplied value.

3.1.2.2.6 Configuration Requirements - When transitioning from the STANDBY to CONFIGURED, the minimum set of required data is based on the service type as specified in table IX.

3.1.2.2.7 Reconfiguration - The IR shall respond to Configuration commands received while in Acquisition, Tracking, or Reacquisition state in one of two manners (Recovery or Restart) depending on the parameters changed.

3.1.2.2.7.1 Recovery Reconfiguration

a. Applicable Parameters - The IR shall perform a Recovery Reconfiguration when it receives a Specific Configuration command to effect one or more of the following changes, but no others:

(1) Change in Modulation Type
(2) Change in I:Q power ratio
(3) Change in I and/or Q data rate
(4) Change in I and/or Q data format
(5) Change in I and/or Q encoding
(6) Change in I and/or Q coding G2 inversion
(7) Change in I and/or Q symbol formatting
(8) Change in I and/or Q interleaving
(9) Change in I and/or Q symbol jitter
(10) Change in operational light state
(11) Change in Service Mode
(12) Change in I and/or Q data recovery

b. Implementation of Recovery Reconfigurations. When the IR receives a configuration command requiring a Recovery Reconfiguration while in the acquisition or reacquisition state, it shall implement the commanded configuration changes and then begin acquisition, without requiring a new Start Acquisition command from the Subsystem Controller. When the IR receives a configuration command requiring a Recovery Reconfiguration while in the tracking state, the following requirements apply:

(1) For Recovery reconfigurations, the IR shall implement the commanded configuration changes in a manner designed to minimize the chance of losing link lock (i.e., carrier lock plus PN code lock, if applicable).

(2) For reconfigurations which affect only one channel of a dual-data-channel configuration, the IR shall implement the changes in a manner designed to minimize the chance of losing channel lock (i.e., symbol synchronizer lock plus Viterbi decoder lock, if applicable).

(3) If lock is lost during the reconfiguration, the IR shall automatically attempt to reacquire the signal, making use of pre-drop-lock knowledge of PN code and carrier dynamics to minimize reacquisition time. Reacquisition shall continue until tracking is achieved or until the IR is commanded otherwise.

c. Timing - The IR shall be capable of completely implementing any commanded Recovery Reconfiguration within 1 second after receipt of the command.

3.1.2.2.7.2 Restart Reconfiguration

a. Applicable Parameters - The IR shall perform a Restart Reconfiguration when it receives a Specific Configuration command to effect any changes other than those listed as Recovery Reconfigurations in paragraph 3.1.2.2.7.1 above, or when it receives a Common Configuration command.

b. Implementation of Restart Reconfigurations - For Restart Reconfigurations, the IR shall stop all ongoing signal tracking operations, implement the commanded configuration changes, and remain in the configured state awaiting a new start acquisition control command. (For Restart Reconfigurations via the Common Configuration command, a Start Forward Model control command will be sent to the IR prior to the Start Acquisition command.) Any user service that is ongoing at the time the Restart Reconfiguration is initiated will be lost.

c. Timing - The IR shall be capable of completely implementing any commanded Restart Reconfiguration within 2 seconds after receipt of the commands.

3.1.2.3 Common Time and Frequency System (CTFS) - The unit shall receive and utilize for timing reference the following CTFS inputs from the Primary Interface.

a. CTFS 10 MHz
b. CTFS 1 Pulse Per Second (1 PPS)
c. CTFS Time of Year (TOY)

3.1.2.3.1 CTFS 10 MHz - The signal characteristics and unit interface requirements are given in table X.

3.1.2.3.2 CTFS 1 PPS - The signal characteristics and unit interface requirements are given in table XI.

3.1.2.3.3 CTFS TOY - The signal characteristics and unit interface requirements are given in table XII.

3.1.2.3.4 Relationship between 10 MHz and 1 PPS - The CTFS 10 MHz and the 1 PPS CTFS signals are coherent in frequency. That is, there are exactly 10 million cycles of the 10 MHz signal between successive leading edges of the 1 PPS pulses. However, the signals are unsynchronized in the sense that the leading edge of the 1 PPS pulse is not necessarily aligned with a zero crossing of the 10 MHz sinusoid.

3.1.2.3.5 Leap Year and Second - The unit makes no special provisions for leap year or leap second. The unit accepts ephemeris data and processes it sequentially from the receipt of the data.

a. Leap year - In the case of leap year, the unit sequences on a twenty-four hour cycle and no special operations procedures are required.

b. Leap second - In the case of leap second, implementation of a leap second during a service will result in a time bias in the ephemeris file and in synchronous commands. This may require special operational procedures.

c. Implications - Leap year has no effect on unit tracking or data services. Leap second has no effect on unit data processing (except for synchronous commands). Tracking services may contain anomalies if the one second bias is not managed operationally.

3.1.2.4 370 MHz IF Input - The unit shall receive from the Primary Interface, USS return signals, when required, on the 370 MHz IF Input. This input will possess the signal characteristics and unit interface requirements described in table XIII.

3.1.2.5 8.5 MHz IF Input - The unit shall receive from the Primary Interface, USS return signals, when required, on the 8.5 MHz IF Input. This input will possess the signal characteristics and unit interface requirements described in table XIV.

3.1.2.6 Return USS Data and Clocks - The unit shall be designed to provide I and Q channel recovered USS return data and clocks for dual and single channel modes.

a. Single data channel, except DG-1 Q-channel BPSK - For all single data channel configurations except DG-1 Q-channel BPSK, the IR will be configured using the I parameters of the configuration command. The IR shall report status for the channel using the I parameters of the reports, and shall provide the output data and clock from the I interface ports.

b. DG-1 Q-channel BPSK - For DG-1 Q-channel BPSK, the IR will be configured using the Q parameters of the configuration command. The IR shall report status for the channel using the Q parameters of the reports, and shall provide the output data and clock from the Q interface ports.

c. SSA and MA dual data channels - For SSA and MA dual data channel configurations, the IR will be configured using both the I and Q parameters of the configuration command. For the channel configured as I, the IR shall report status for the channel using the I parameters of the reports, and shall provide the output data and clock from the I interface ports. For the channel configured as Q, the IR shall report status for the channel using the Q parameters of the reports, and shall provide the output data and clock from the Q interface ports.

d. KSA dual data channels - For KSA dual data channel configurations, the IR will be configured using both the I and Q parameters of the configuration command. For the channel configured as I, the IR shall report status for the channel using the I parameters of the reports. For the channel configured as Q, the IR shall report status for the channel using the Q parameters of the reports.

(1) Data recovery required on both channels - When Data Recovery is set to "Required" for both I and Q channels, the IR shall provide the I output data and clock from the I interface ports, and the Q output data and clock from the Q interface ports.

(2) Data recovery required on only one channel - When Data Recovery is set to "Required" for only one of the two channels, the IR shall provide the output data and clock for that channel from the I interface port, regardless of whether the channel is configured as I or Q.

e. KSHR - For KSHR services, the IR will be configured with information about Channel 2 using the I parameters of the configuration command, and with information about Channel 1 using the Q parameters. The IR shall report status for Channel 2 using the I parameters of the reports, and shall provide the output data and clock from the I interface ports. The IR shall report status for Channel 1 using the Q parameters of the reports, and shall provide the output data and clock from the Q interface ports.

f. Signal characteristics - The signal characteristics and unit interface requirements of these signals are described in table XV. These outputs go from the Integrated Receiver to the Primary Interface.

3.1.2.7 Recovered PN Code Outputs - The unit shall be designed to provide recovered I and Q channel PN codes, as applicable, and PN lock status. The signal characteristics and unit interface requirements of these signals are described in table XVI. These outputs go from the Integrated Receiver to the Primary Interface.

3.1.2.8 KSA Autotrack Outputs - The unit shall be designed to provide KSA autotrack outputs. The signal characteristics and unit interface requirements of these signals are described in table XVII. These go from the Integrated Receiver to the Primary Interface.

3.1.2.9 SSA Combining Inputs/Outputs - The unit shall be designed to provide and receive data and clock signals to support SSA combining for SSAR and SSHR services. That is, the unit shall provide recovered data with soft decisions and synchronous clock as outputs to the Primary Interface for use by another Integrated Receiver. Conversely, the unit shall receive as inputs, when SSA Combining is required, the recovered data with soft decisions and synchronous clock from another Integrated Receiver via the Primary Interface. The combining signals consist of five data lines for each I and Q channel and I and Q clocks. SSHR services require I channel, only. The signal characteristics and unit interface requirements for these signals are described in table XVIII. Clock and data relationships are illustrated in figure 11.

3.1.2.10 Controls, Indicators, and Test Points - To support maintenance and operation of the unit, controls, indicators, and test points are provided on the front panel of the unit and on a maintenance panel. For switches with mechanical positions, the position will provide an indication of status. AC power shall be indicated by switch position and by a status lamp.

3.1.2.10.1 Controls - Controls are provided on the front panel and on the maintenance panel.

a. Front panel - The unit shall have the following front panel controls:

   (1) Visual AC Power On/Off
   (2) Local/Remote Switch
   (3) Initiate Built-in Test
   (4) Display Panel, also an indicator

b. Maintenance panel - A reset switch shall be provided on the maintenance panel.

c. Local/Remote - A Local/Remote switch shall be provided on the IR front panel. The switch shall have the following controls:

   (1) The Local/Remote selector switch on the front panel shall enable an operator to gain local control of the IR, or to relinquish control to the 1553 Bus. Selection or relinquishment of local control shall be possible only from the front panel.

   (2) When in Remote mode, the IR shall respond only to commands provided over the 1553 Bus, and not to front panel controls, except those for status display and for Local/Remote selection.

   (3) When in Local mode, the IR shall respond only to front panel controls, and not to commands provided over the 1553 Bus, except for status requests.

   (4) All BIT/BITE functions shall be commandable from the front panel when the IR is in local mode.

   (5) All required front-panel status shall be available, regardless of whether local or remote mode is selected.

   (6) All status shall be provided over the 1553 Bus, upon command from the SSA Control HWCI, regardless of whether local or remote mode is selected.

   (7) Changing from Local mode to Remote mode, or Remote to Local, shall not alter the configuration state of the unit.

3.1.2.10.2 Indicators - Indicators are provided on the unit's front panel. Performance requirements for indicators are provided in 3.2.1 Performance.

a. Display - An interactive touch panel display is provided on the front panel. The panel is capable of displaying 480 alphanumeric characters in a 12 line by 40 character format.

b. Power supply status - Indicator lamps provide a positive indication for each of the following power supplies:

(1) Primary AC Power
(2) + 5 volts DC
(3) + 5 volts DC (RF supply)
(4) + 12 volts DC
(5) + 15 volts DC
(6) - 5.2 volts DC
(7) - 12 volts DC
(8) - 15 volts DC

c. Unit status - The following indicator lamps, as configured by the Operational Light State parameter of the Specific Configuration Command or by the Front panel, provide unit status:

(1) Normal
(2) Fault
(3) Test
(4) On-line
(5) Standby
(6) Maintenance

d. Switch positions - Switch position shall be used to indicate AC power on or off, and to indicate local or remote status.

3.1.2.10.3 Test Points - Test points are provided on both the front panel and on the maintenance panel.

a. Front panel - Test points for the 370 MHz IF Input and the 8.5 MHz IF Input will be provided on the front panel. These points will have 20 dB, +/- 2 dB of isolation from the inputs that they monitor. They are 50 ohm.

b. Maintenance panel - The following test points are provided on the maintenance panel:

(1) Power supplies:

+ 5 volts DC
+ 5 volts DC (RF supply)
+ 12 volts DC
+ 15 volts DC
- 5.2 volts DC
- 12 volts DC
- 15 volts DC

(2) Test signals:

I and Q data and clocks
I and Q PN codes, clock, and PN epoch
DMSS Output Signals
  Code Early Minus Late
  Carrier Phase Error
  Symbol Sync Error
  Signal Level
Local Oscillator Signals
  70 MHz from Downconverter No. 1
  300 MHz from Downconverter No. 1
  70 MHz from Downconverter No. 2
Common Time and Frequency System
  CTFS 1 PPS External
  CTFS 1 PPS Internal
  CTFS 10 MHz

3.1.3 Major Component List

The components of the Integrated Receiver are listed in IEC Drawing Number 7472102. The major components are:

a. 7473000 Timing Generator PWA
b. 7473100 Demodulator Symbol/Synchronizer PWA
c. 7473200 Acquisition Processor PWA
d. 7473300 Pseudo-Noise Processor PWA
e. 7473400 Output Processor PWA
f. 7473600 Modem Control Processor PWA
g. 7474000 RF Downconverter 1 PWA
h. 7474300 RF Downconverter 2 PWA
i. 7474600 Synthesizer PWA
j. 7476100 Demodulator Processor PWA
k. 7510500 High Rate Downconverter PWA

Notes:

1) PWA stands for printed wiring assembly

2) 7473100 Demodulator Symbol/Synchronizer PWA is used in two places.

3) 7510500 High Rate Downconverter PWA may be included in any Integrated Receiver, but is only required in KSA configurations.

3.1.4 Government Furnished Property List

The unit neither requires nor contains any government furnished property.

3.1.5 Government Loaned Property List

The unit neither requires nor contains any government loaned property.

3.2 CHARACTERISTICS

3.2.1 Performance

This section provides the performance characteristics of the Integrated Receiver. The unit shall perform the functions stated over the limits specified.

3.2.1.1 Signal Formats, Parameters and Constraints - The unit shall receive and process all user Service Subsystem (USS) return signals for all MAR, SSAR and KSAR services, including test signals generated by the Performance Measuring and Monitoring System (PMMS). Necessary details of signal formats, parameters and constraints for return signals over which unit performance is specified are provided in the body of this specification. Specific details of all applicable USS return signals are described in Appendix I. Refer to STGT-HE-04-05, -07 and -10 for complete input signal definition and requirements.

3.2.1.1.1 Input User Signals - The unit will support input user signals at two nominal intermediate frequencies; 8.5 MHz and 370 MHz. All signals are referenced to the input of the Integrated Receiver.

a. SSAR inputs - S-Band Single Access Return (SSAR) and S-Shuttle Return (SSHR) services are supported only on the 370 MHz IF Input. The IR shall perform demodulation, data recovery, and tracking service functions for all SSAR and SSHR services.

b. KSAR inputs - K-Band Single Access Return (KSAR) and K-Shuttle Return (KSHR) services utilize both IF inputs for various return service configurations. The IR shall perform demodulation, tracking service and autotrack error extraction functions for all KSAR and KSHR modes and services. In addition, the IR shall perform all necessary data recovery functions for channel symbol rates less than 6 Msps, which includes recovery of the KSHR subcarrier.

c. MAR inputs - Multiple Access Return (MAR) services are supported only on the 8.5 MHz IF Input. The IR shall perform demodulation, data recovery, and tracking service functions for all MAR modes and services.

3.2.1.1.2 Parameters and Constraints - Specified performance is required for the USS return signals described in Appendix I, with the signal distortions and constraints listed below. The unit shall deliver specified performance within these boundaries.

3.2.1.1.2.1 Required Signal Energy - The unit shall provide specified performance when input return signals possess the following signal plus noise power, signal to noise ratios, and C/No variations.

3.2.1.1.2.1.1 Signal Plus Noise Power - Input signal plus noise power at the 370 MHz IF and 8.5 MHz IF inputs varies according to service (SSA, KSA, or MA), and according to whether the input originates from a user return signal or from the PMMS.

a. For SSAR - The input power at the 370 MHz IF Input will be -25.5 dBm, plus or minus 6 dB, in the following reference 3 dB bandwidths centered about 370 MHz:

   (1) User return signal - The reference 3 dB bandwidth for an SSA user return signal, or for an end-to-end PMMS signal, is 17 MHz.

   (2) Internal loopback - The reference 3 dB bandwidth for an SSA PMMS internal loopback test signal is 30 MHz.

   (3) Spurious signals - Regardless of signal source, the total RSS value of all spurious signals within a 17 MHz bandwidth, centered about 370 MHz, will be -30 dBc, maximum; no single spurious signal will exceed -40 dBc.

b. For KSAR, 370 MHz IF Input - The input power at the 370 MHz IF Input will be -20 dBm, plus or minus 4 dB, in the following reference 3 dB bandwidths centered about 370 MHz:

   (1) User return signal - The reference 3 dB bandwidth for a KSA user return signal, or for an end-to-end PMMS signal is 240 MHz.

   (2) Internal loopback, Test Modem - The reference 3 dB bandwidth for a KSA PMMS internal loopback signal which has noise added by at the KSA Low Data Rate Equipment Test Modem is 30 MHz.

(3) Internal loopback, HDR PTE - The reference 3 dB bandwidth for a KSA PMMS internal loopback signal which has noise added by at the KSA High Data Rate PMMS Test Equipment is 300 MHz.

(4) Spurious signals - Regardless of the signal source, the total RSS of all spurious signals over a 30 MHz bandwidth, centered about 370 MHz, will be -30 dBc, maximum. Individual spurious signals form 10 MHz to 2,000 MHz will be -40 dBc, maximum.

c. For KSAR, 8.5 MHz IF Input - The input power at the 8.5 MHz IF Input will be -20 dBm, plus or minus 4 dB, in a reference 3 dB 15 MHz low pass band. No distinction is made between user signals and test signals.

d. For MAR, 8.5 MHz IF Input - The input power at the 8.5 MHz IF Input will be -20 dBm in the following reference bandwidths:

(1) User return signal - The reference 3 dB bandwidth for a MA user return signal, or for an end-to-end PMMS signal is 6 MHz, centered about 8.5 MHz. Signal plus noise may vary by plus or minus 20 dB in this bandwidth.

(2) Internal loopback - The reference 3 dB bandwidth for a MA PMSS internal loopback signal is a 15 MHz low pass. Signal plus noise may vary by plus or minus 4 dB in this bandwidth.

(3) Spurious signals - Regardless of the signal source, the total spurious power within the 6 MHz reference band is -30 dBc, maximum. Individual spurious signals from 1 MHz to 16 MHz will be -40 dBc, maximum.

(4) Out of band power - The total out of band power will be -5 dBc, maximum, outside 6 MHz reference band.

3.2.1.1.2.1.2 Signal to Noise Ratio - Return service signal to noise ratio is provided in terms of C/No, where C is the received carrier power and No is the noise power, referenced to a one Hz bandwidth. Input C/No requirements are expressed in terms of achievable data rate (ADR) referenced to a given probability of error and implementation loss. The bit error probability of the IR shall be:

a. Reference formula - The following formula shall determine the necessary C/No, and hence, the minimum signal energy required to obtain the achievable data rate, Rb.

$$C/No = Eb/No + 10\log Rb + L[P_E, Rb] + L(A)$$

where:

(1) All values are in decibels.

(2) Eb/No is the theoretical value for the reference probability of error, P_E, at the referenced ADR operating point. Values are specified for P_E equal to 10^{-5}, 10^{-6}, and 10^{-7}. For S-Shuttle, a point value is specified at 10^{-4}.

(3) $L[P_E,Rb]$ is the allowable implementation loss for the given data channel and operating condition. Rb is the channel bit rate; P_E is the referenced probability of error (also known as bit error rate). Implementation losses are listed in the following tables:

a) SSAR Allowable Implementation Loss for Rate 1/2 Coding, table XIX.
b) SSAR Allowable Implementation Loss for Rate 1/3 Coding, table XX.
c) SSHR Allowable Implementation Loss for Rate 1/3 Coding, table XXI.
d) KSAR Allowable Implementation Loss for Rate 1/2 Coding, table XXII.
e) KSAR Allowable Implementation Loss for Uncoded Operation, table XXIII.

f) KSHR Allowable Implementation Loss for Channels 1 and 2, Uncoded, table XIV.
g) MAR Allowable Implementation Loss for Rate 1/2 Coding, table XXV.

(4) L(A) is an additional implementation loss, if applicable, allowed for a particular mode of operation (e.g., .1 dB is allowed for NRZ-M or -S when the channel is convolutionally encoded).

(5) To satisfy the requirements for achievable data rate (ADR), the above value for C/No must be greater than or equal to the amount required to satisfy the equality at the given data rate, Rb.

b. C/No required for each channel - Each data channel, including subcarriers, must satisfy the above requirements for minimum C/No.

c. Relationship to total C/No - The total C/No is related to the per channel C/No by the following relationships.

(1) Single data channel

(a) 1:1 power ratio - For DG1 with input signals with identical and synchronous data on both I and Q channels and for which the I/Q signal power ratio is 1:1, the total signal power will be consistent with that required for a single channel:

C/No(tot) = C/No(channel)

(b) 1:r power ratio - For DG1 with input signals with identical and synchronous data on both I and Q channels and for which unequal signal strength is provided (power ratio 1:r), the strong channel signal power will be consistent with that required for a single channel:

C/No(tot) = 10 log (1 + r) + C/No(channel)

(c) Failed transponder - For failed transponder modes where there is a residual, but unmodulated, quadrature component in one channel, and a data modulated component in the remaining channel, the power required to support the remaining channel will be consistent with that required for a single channel:

C/No(tot) = 10 log (1+f) + C/No(channel)

where f = ratio of the residual carrier power in the failed channel to the power in the operational channel.

(d) DG2, SQPSK : C/No(tot) = C/No(channel) or 48 dB-Hz, whichever is greater

(e) DG2, BPSK - All of the available power is in a single channel for DG2 BPSK. There for the power required to support the channel is:

C/No(tot) = C/No(channel)

(f) S-Shuttle - S-Shuttle return services are BPSK modulated; the power required to support the single channel is, then:

C/No(tot) = C/No(channel)

(2) Dual data channels - For all dual channel configurations,

CNRtot (Rbi, Pei, Rbq, Peq) = 10 log [(1+r)/r] +
Max {CNRch (Rbi, Pei), 10 log (r) + CNRch (Rbq, Peq)} dB-Hz,

where

r is the I:Q power ratio.

Rbi is the data rate of the I data channel in bits per second.

Rbq is the data rate of the Q data channel in bits per second.

Pei is the specified bit error probability for the I data channel.

Peq is the specified bit error probability for the Q data channel.

CNRch (Rbi, Pei) is the minimum channel C/No for the I data channel in dB-Hz as defined in equation

$$C/No = E_b/No + 10 \text{ Log } R_b + L [P_E, R_b] + L(A)$$

likewise, CNRch (Rba, Pea) is the minimum channel C/No for the Q data channel in dB-Hz, and Max {a,b} denotes the greater of a and b.

(3) K-Shuttle channels - as given in 3.2.1.1.2.1.3.g and h.

3.2.1.1.2.1.3 C/No Variations - C/No may vary during a given support period and is referenced to the Service Maximum Data Rates (SMDR) provided in the IR_SPECIFIC_CONFIGURATION_COMMAND.

a. Dynamic range, general case - The C/No may range from -3 dB to +12 dB relative to the reference C/No for $P_E = 10^{-5}$ for the Service Maximum Data Rate given in the IR_SPECIFIC_CONFIGURATION_COMMAND. Service Maximum Data Rates represent the maximum I and Q rates consistent with the anticipated C/No for the service.

b. Variation rate - The input variation will not exceed 10 dB/second.

c. S-Shuttle constraints - For S-Shuttle Modes 1 and 2, the C/No may range from 52.1 dB-Hz to 64.1 dB-Hz. For S-Shuttle Mode 3, the C/No will be at least 35.2 dB/Hz. The C/No variation rate for S-Shuttle modes will not exceed 10 dB/second.

d. Range Zero Set - The C/No for Range Zero Set will be:

(1) For SSAR - For SSA Range Zero Set, the C/No will be at least 63 dB-Hz, and will not vary by more than 1 dB/second.

(2) For KSAR - For KSA Range Zero Set, the C/No will be at least 69 dB-Hz, and will not vary by more than 1 dB/second.

(3) For MAR - For MAR Range Zero Set, the C/No will be at least 55 dB-Hz, and will not vary by more than 1 dB/second.

e. MA Calibration - For MA Calibration, the C/No may range from 25 dB-Hz to 45 dB/Hz, and will not vary by more than 10 dB/second.

f. KSAR - The C/No may range from -6 dB to +12 dB relative to the reference C/No for $P_E = 10^{-5}$ for the Service Maximum Data Rate given in the IR_SPECIFIC_CONFIGURATION_COMMAND.

g. KSHR Mode 1 - The C/No will be in the range from 83.4 to 91.4 dB-Hz

h. KSHR Mode 2 - The C/No at the 8.5 MHz IF input will be at least 77 dB-Hz.

3.2.1.1.2.2 Data Rates - Data rates will be provided to the unit in the IR_SPECIFIC_CONFIGURATION_COMMAND. The actual user data rate will be within +/- 0.1 percent of the commanded data rate provided in the IR_SPECIFIC_CONFIGURATION_COMMAND.

3.2.1.1.2.3 I:Q Power Ratio Accuracy - The actual user I channel to Q channel power ratio will be within +/- 0.4 dB of the commanded I:Q power ratio provided in the IR_SPECIFIC_CONFIGURATION_COMMAND.

3.2.1.1.2.4 Symbol Transition Density - Within any sequence of 512 symbols (symbols are bits for uncoded operation), the number of transitions will be greater than or equal to 128 and the maximum number of consecutive symbols without a transition will be less than or equal to 64.

3.2.1.1.2.5 Symbol (Data) Jitter and Jitter Rate

a. Symbol (data) jitter - The clock frequency jitter will be less than or equal to 0.1 percent of the symbol rate, peak for sinusoidal jitter, or three sigma for random jitter. For K-Shuttle, only, the jitter may exceed this amount but will be less than or equal to 2.0 percent.

b. Symbol (data) jitter rate - The clock frequency jitter rate will be less than or equal to 0.1 percent of the symbol rate, peak for sinusoidal jitter, or three sigma for random jitter. For K-Shuttle, only, the jitter rate may exceed this amount but will be less than or equal to 2.0 percent.

3.2.1.1.2.6 Signal Distortions - The IR shall meet all acquisition, tracking, and bit error rate requirements with input user signals possessing the following types and amounts of distortions. Definitions for these parameters are as described in STDN No. 101.2 Revision 6, Appendix I.

a. Data asymmetry : +/- 3 percent maximum

b. Maximum Data transition time :

    (1) SSAR, SSHR and MAR - 17 nsec or 5 percent of the bit period, whichever is greater;

    (2) KSAR and KSHR - 800 psec or 5 percent of the bit period, whichever is greater

c. I/Q data skew : 3 percent maximum

    This parameter applies to DG1 single data channel QPSK and DG2 single data channel SQPSK.

d. I/Q PN skew : 0.01 chip, maximum

    This parameter applies to DG1, including Range Zero Set and MA Calibration.

e. PN code power suppression : 0.3 dB, maximum

    This parameter applies to DG1, including Range Zero Set and MA Calibration.

f. Mode 2 PN chip rate : +/- 0.01 chip/sec, peak, Relative to Absolute coherence with Carrier.

g. BPSK phase imbalance : +/- 3°, maximum

h. QPSK phase imbalance : 90 +/- 3°, maximum

i. Gain imbalance : +/- 0.25 dB, maximum, over signal bandwidth

j. Phase noise : As specified in table XXVI.

k. Spurious phase modulation (PM) : 3° rms, maximum, over the following bandwidths:

(1) SSAR and MAR : 100 Hz to 6 MHz
(2) SSHR : 100 Hz to 600 kHz
(3) KSAR and KSHR : 100 Hz to 150 MHz

l. Incidental amplitude modulation (AM) : 6 percent, maximum (3 sigma), with the following constraints:

(1) At frequencies greater than 10 Hz for data rates less than 1 kbps;
(2) At frequencies greater than 100 Hz for data rates greater than or equal to 1 kbps.

m. Minimum two-sided 3 dB IF bandwidth :

(1) DG-1 : Two times the maximum channel symbol rate (four times for biphase symbols) or 6 MHz, whichever is greater;

(2) DG-2: Two times the maximum channel symbol rate (four times for biphase symbols) or 1 MHz, whichever is greater;

(3) SSHR : Four times maximum channel symbol rate;

(4) KSHR : Greater than 200 MHz.

3.2.1.1.2.7 Radio Frequency Interference (RFI) - In addition to the above signal distortions, input signals may contain pulsed radio frequency interference (RFI) with pulse widths up to 5 microseconds for SSAR and MAR (1 microsecond for KSAR), duty cycles of $\leq$ 1%, and peak power of up to 10 dB above the received average power.

a. No damage due to RFI - The unit shall be designed so as not to experience damage or cumulative degradation due to this amount of RFI.

b. Effect of each pulse - The unit shall not extend the effect of each pulse by more than one symbol, exclusive of the delay introduced by signal processing operations with inherent memory, such as convolutional decoding and differential formatting.

c. Acquisition and tracking - The unit shall provide for the operation of all acquisition and tracking functions, from IF to baseband, in the presence of this amount of RFI.

d. Bit error rate (BER) - Bit error rate (BER) performance is not specified in the presence of RFI.

3.2.1.1.2.8 IF Input Frequency Dynamics - The IR shall be capable of receiving and processing IF signals for the SSAR, KSAR and MAR services as specified in table XXVII, per the following constraints:

a. TDRS Maneuvers - The IR shall be designed to operate in the presence of TDRS maneuvers as listed. The performance requirements for bit error probability, cycle slip, or tracking services do not apply during periods of TDRS maneuvering.

b. MA Calibration - IF requirements are as specified for the MAR service with the following exceptions:

(1) Doppler Offset (total) : +/- 3.7 kHz
(2) Frequency Rate : +/- 1.5 Hz/sec
(3) Frequency acceleration : +/- 0.0001 Hz/sec^2

c. KSHR Subcarrier - KSHR subcarrier IF requirements are as follows:

(1) Center Frequency : 8.5 MHz
(2) Frequency Offset : +/- 833 Hz

3.2.1.1.2.9 Autotrack Signals - For all KSAR configurations and KSHR Mode 1 the Integrated Receiver shall perform signal acquisition and autotrack error term extraction as specified in 3.2.1.2 and 3.2.1.4.4. The autotrack error signal that is amplitude modulated onto the return link has the form:

$$V_R \cos(w_R t + P_R(t)) * [1 + M_e(t)] * [1 + N(t)]$$

where,

w_R = return signal RF carrier frequency (rad/sec)
$P_R(t)$ = return phase modulation
$N(t)$ = Incidental AM component
$M_e(t)$ = Modulation index, $0 \leq |M_e(t)| \leq 0.14$, and where the error signal modulation, $M_e(t)$ takes the form:

$$M_e(t) = \sum_n \frac{\Delta V_n}{\Delta V_R} P_s(t - nT_s) * \sum_m P_c(t - mT_c)$$

and

ΔV_n = Sample of n^{th} error channel voltage (n=1,2)
ΔV_R = Return channel voltage
$-M \leq (\Delta V_n / V_R) \leq +M$, where M = maximum modulation index = 0.14
$P_s(t - nT_s)$ = 1, for $nT_s \leq t \leq (n+1) T_s$
0, elsewhere
Time sampling of two error channels with 50% duty factor
$P_c(t - mT_c)$ = A_M for $mT_c \leq t \leq (m+1) T_c$, where $A_M = \pm 1$
Manchester coded PN code on error signal
$T_c = 5.0 \times 10^{-4}$ seconds
$T_s = 0.032$ seconds
Modulation Index Magnitude, $0 \leq | M_e(t) | \leq 0.14$

The monopulse channels are time division multiplexed to form a single error signal waveform. The multiplexed signal switches between error channels every 32 milliseconds. A 1024 bit Manchester code sequence operating at 1000 symbols/sec is applied to the error signal. The error signal is amplitude modulated onto the return link with a modulation index that may be as low as zero during tracking and as high as 0.14 during pull-in.

3.2.1.1.3 Predicted user and TDRS Ephemeris Data - The associated automatic data processing equipment will provide, via the data bus, the Integrated Receiver with predicted delay, frequency, and Tracking and Data Relay Satellite (TDRS) Doppler profiles, to aid in acquisition and tracking. The major error component in the predicted delay and frequency profiles is due to along-track uncertainty in user ephemeris; therefore, most of the error in these profiles can be modeled as a slowly varying time bias. This time bias will be between -9 and +9 seconds for SSA and MA services; it will be between -4.5 and +4.5 seconds for KSA services. The same value of time bias applies to both the delay and frequency profiles. The time bias model does not apply to the TDRS Doppler profile.

3.2.1.1.3.1 Coherent (Two-Way) Services - Coherent services are:

a. SSAR DG1 Modes 1 and 3
b. SSAR DG2 Mode 1
c. SSHR Mode 3
d. SSHR Mode 1 and 2, when commanded
e. SSA Range Zero Set
f. KSAR DG1 Modes 1 and 3
g. KSAR DG2 Mode 1
h. KSA Range Zero Set
i. MAR DG1 Mode 1
j. MAR Range Zero Set
k. MAR Calibration

3.2.1.1.3.1.1 MDP Commands - The unit will be provided with all the relevant configuration and control commands and Doppler compensation profiles provided to the associated Modulator/Doppler Predictor (MDP). This information is sufficient to allow the Integrated Receiver to propagate in time the IF carrier frequency and PN code state transmitted by the MDP.

3.2.1.1.3.1.2 Delay Profile - The unit will be provided with a profile of the predicted round-trip delay, $\hat{D}(t)$, which is defined as the estimated total delay from MDP to IR of a signal arriving at the IR at time t (i.e., a signal transmitted by the MDP at time $[t - \hat{D}(t)]$ arrives at the IR at time t, within the accuracy of the prediction).

a. Purpose - The predicted delay profile is provided to the IR for use in:

(1) Predicting received PN code state for acquisition and tracking, in conjunction with the MDP commands previously described;

(2) Resolving ambiguity in range delay measurements;

(3) Estimating time bias for DG1 Modes 1 and 3 services. (These are services that support range delay measurement). Time bias estimation is useful in shortening reacquisition time and in improving the accuracy of Doppler measurements performed with MDP Doppler compensation enabled.

b. Format The delay profile $\hat{D}$ (t) will be provided as a table of delay values (in nanoseconds) at 0.5 second intervals aligned with the CTFS 1 PPS epochs.

c. Accuracy - The maximum error boundaries for predicted delay profiles as a function of time bias are provided in figure 12 for SSAR and SSHR services, in figure 13 for KSAR and KSHR services, and in figure 14 for MAR services.

3.2.1.1.3.1.3 Frequency Profile - The unit will be provided with the information necessary to construct a profile of predicted input carrier frequency $\hat{f}_{IR}(t)$, which is defined as the estimated instantaneous IF carrier frequency that will be present at the IR input as a function of time. The profile components provided to the IR assume that the associated MDP is performing Doppler compensation; the effects of the MDP control commands are expressly excluded from $\hat{f}_{IR}(t)$ and must be added by the IR. The profile $\hat{f}_{IR}(t)$ does include the effects of user and TDRS motion.

a. Purpose - The predicted frequency profile can be used by the IR for the following purposes:

(1) Frequency precorrection to aid acquisition and reduce loop stress during tracking;

(2) Time bias estimation for nonspread services. (These services do not support range delay measurement);

b. Format - The frequency profile is the sum of three components:

$$\hat{f}_{IR}(t) = f_{IF} + df_R + d\hat{f}_{IR}(t), \qquad [3\text{-}1]$$

where:

(1) f_{IF} is a constant = $370.\bar{0}$ MHz (SSA & KSA) or $8.5\bar{0}$ MHz (mA). The overbar indicates that the final zero is repeated to the accuracy of the CTFS.

(2) df_R is a base frequency offset provided to the IR via the data bus. For SSAR and SSHR, the base frequency is in the range -250 kHz to +250 kHz; for KSAR and KSHR, the base frequency is in the range -770 kHz to +770 kHz; and for MAR, the base frequency is in the range -100 kHz to +100 kHz.

(3) $df_{IR}(t)$ is a profile of deviation frequency versus time which will be provided to the IR in the form of a table of values space at 0.5 second intervals aligned with the CTFS 1 PPS epochs.

c. Accuracy - The maximum error boundaries for predicted frequency profiles as a function of time bias are provided in figure 12 for SSAR and SSHR services, in figure 13 for KSAR and KSHR services, and in figure 14 for MAR services.

3.2.1.1.3.1.4 TDRS Doppler Profile - The IR will be provided with a profile of the predicted TDRS round-trip Doppler shift, $\hat{f}_{TD}(t)$, referenced to the TDRS translation frequency as follows:

$$\hat{f}_{TD}(t) = f_{trt} \times \hat{a}(t) \qquad [3\text{-}1a]$$

where:

(1) f_{trt} is the zero-motion TDRS Return Translation Frequency

(2) $\hat{a}(t)$ is the estimate of the fractional Doppler shift experienced by a signal transmitted from the ground and coherently turned around by the TDRS, which arrives at the IR at time t.

a. Purpose - The predicted TDRS Doppler profile is provided to the IR for use in PN code aiding of carrier acquisition, or carrier aiding of PN code acquisition. The instantaneous PN code rate at the input to the IR, $r_{IR}(t)$ can be expressed in terms of the instantaneous IF carrier frequency at the input to the IR, $f_{IR}(t)$, to a very high degree of accuracy as follows:

$$r_{IR}(t) = [f_{IR}(t) - f_{trg} - f_{trt} - \hat{f}_{TD}(t)] * P/R \qquad [3\text{-}2]$$

where

P = 31/(96*221) for SSAR and MAR, SSA RZS and MARZS.
P = 31/(96*1469) for KSAR, KSA RZS
R = 240/221 for SSAR and MAR, and
R = 1600/1469 for KSAR

f_{trg} is the ground station return translation frequency provided to the unit.

f_{trt} is the zero-motion TDRS return translation frequency provided to the unit.

b. Format - The TDRS Doppler profile, $\hat{f}_{TD}(t)$, will be provided as a table of frequency values at 0.5 second intervals aligned with the CTFS 1 PPS epoch.

c. Accuracy - Accuracy will be +/- 0.8 Hz for SSA. For KSA, accuracy will be +/- .1 Hz.
For MA, accuracy will be ± 0.2 Hz

3.2.1.1.3.1.5 Doppler Update - The IR shall be capable of updating or overwriting stored profile data without affecting performance. Newly supplied profile data shall be implemented no later than 10 seconds after receipt. The IR shall be capable of storing up to 50 minutes of ephemeris profiles.

3.2.1.1.3.2 Noncoherent (One-Way) Services - Noncoherent services are:

a. SSAR DG1 Mode 2
b. SSAR DG2 Mode 2
c. SSHR Mode 1 and 2, when commanded
d. KSAR DG1 Mode 2
e. KSAR DG2 Mode 2
f. KSHR Mode 1
g. MAR DG1 Mode 2

3.2.1.1.3.2.1 MDP Commands - As described in 3.2.1.1.3.1.1, MDP Commands. These commands are not necessary for noncoherent service, but are provided to the unit in anticipation of reconfiguration to coherent mode.

3.2.1.1.3.2.2 Delay Profile - As described in 3.2.1.1.3.1.2, Delay Profile. These commands are not necessary for noncoherent service, but are provided to the unit in anticipation of reconfiguration to coherent mode.

3.2.1.1.3.2.3 Frequency Profile - The Integrated Receiver will be provided with the component necessary to construct a profile of predicted input carrier frequency, $\hat{f}_{IR}(t)$, which is defined as the estimated instantaneous IF carrier frequency that will be present at the unit input as a function of time. The profile includes the predictable component of user oscillator offset, as well as the effects of user and TDRS motion.

a. Purpose - The predicted frequency profile is used by the IR for frequency pre-correction to aid acquisition and reduce loop stress during tracking.

b. Format - As described in 3.2.1.1.3.1.3.b, Format.

c. Accuracy - See figures 12, 13 and 14.

3.2.1.1.3.2.4 TDRS Doppler Profile - This profile is provided as described in 3.2.1.1.3.1.4, TDRS Doppler Profile.

3.2.1.2 PN Code and Carrier Acquisition

3.2.1.2.1 Initial Acquisition - Initial carrier and code (if applicable) acquisition time shall not exceed the values specified in table XXVIII for the C/No values shown, where C/No is referenced at the IR IF input. Acquisition time shall be measured from the receipt of the IR_START_ACQUISITION_COMMAND control command to the time at which PN code (if applicable) and carrier phase lock are achieved. For PN code acquisition, the time to acquire includes the time required to search the PN code uncertainty. Acquisition shall be achieved within the specified time given the IR is provided with predicted user ephemeris information as described in 3.2.1.1.3 with the resultant residual errors listed in figures 12, 13, and 14.

The following acquisition performance requirements apply provided signal energy is present at the IR input when IR_START_ACQUISITION_COMMAND is received:

a. Probability of acquisition - 0.9 minimum within times specified;

b. Required signal energy - The signal energy required for acquisition shall be as described in 3.2.1.1.2.1 with acquisition required at a C/No consistent with P_E equal to 10^{-5}. For SSHR only, acquisition shall be at a P_E equal to 10^{-4};

c. Acquisition failure - In the event that acquisition does not occur within the time specified, the IR shall continue to search the full uncertainty region until acquisition is achieved or until commanded otherwise.

d. Commanded new acquisition - When the IR receives an IR_ START_ACQUISITION_COMMAND while in the acquisition, tracking or reacquisition state, it shall force a loss of all loop locks and begin the initial acquisition process.

e. Expanded search - When commanded with the IR_EXPAND_FREQ_SEARCH_WINDOW_ COMMAND, the IR shall provide and expanded search capability for SSA, MA and KSA DG-1 mode 2 and SSA and KSA DG-2 mode 2 services. The expanded search range and acquisition time are defined in figures 12, 13, and 14 and table XXVIII.

3.2.1.2.2 False Lock - During signal acquisition and tracking, the IR shall protect against false carrier acquisition and false acquisition to code sidebands, including multipath. Multipath is defined to be specular reflections whose delay with respect to the direct signal lies within the range of 700 nsec to 5 milliseconds and whose received signal level is down at least 19 dB for KSA and SSA, and at least 6 dB for MA, with respect to the direct signal.

3.2.1.2.3 Reacquisition - The IR shall detect a loss-of-lock condition and automatically initiate reacquisition using pre-drop lock tracking data as an aid. Reacquisition shall be initiated when loss-of-lock is detected while in the tracking state only. For the purposes of this requirement, the IR must have been tracking for at least three seconds.

a. Normal Reacquisition time - For all SSA and KSA services, and for all MA services except for MA calibration, reacquisition time shall be 1 second or less, with a minimum probability of acquisition of 0.99, for the minimum C/No required for a 10^{-5} P_E (10^{-4} P_E for SSHR). This requirement does not apply for outages caused by signal dynamics in excess of those specified in table XXVII, which includes loss-of-lock due to signal dynamics due to transitions between free flight and powered flight for SSA services. This reacquisition time shall be met for all outages of duration less than 10 seconds.

b. MA Calibration Reacquisition time - During MA calibration, loss-of-lock may occur as a result of abrupt jumps in input C/No, ranging from the minimum specified in table XXVIII to 20 dB higher. Upon loss-of-lock, the IR shall reacquire within 5 seconds, maximum.

c. Commanded Acquisition - The unit shall automatically continue the reacquisition process until acquisition is successfully achieved, or the unit is commanded otherwise. When commanded with the IR_START_ACQUISITION_COMMAND while in the reacquisition state, the unit shall automatically halt the reacquisition process and initiate the initial acquisition process defined in 3.2.1.2.1.

3.2.1.3 Symbol/Decoder/Deinterleaver Synchronization - This paragraph specifies the minimum required acquisition time for all MA, SSA and KSA modes and services, for uncoded, coded and decoder bypass modes. Acquisition performance shall be met under the jitter and jitter rate conditions specified in 3.2.1.1.2.5 and with the following data transition density conditions:

a. Uncoded operation - Within any sequence of 512 bits, the number of transitions will be greater than or equal to 128 and the maximum number of consecutive symbols without a transition will be less than or equal to 64.

b. Coded operation - The minimum data bit transition density is 64 data bit transitions within any sequence of 512 bits with no more than 64 consecutive data bits without a transition.

3.2.1.3.1 Symbol Synchronization with Uncoded Data - For KSA and KSHR uncoded services, the minimum symbol transition density and minimum C/No required for a P_E equal to 10^{-5}, the time to synchronization shall not exceed the values specified below:

a. 300/data rate(bps) for biphase symbols, with 90 percent probability;
b. 3000/data rate (bps) for NRZ symbols, with 90 percent probability;

3.2.1.3.1.1 Measurement Time - Symbol synchronization time shall be measured from the time the carrier lock signal (rear panel) goes true until the time symbol synchronization is achieved. Symbol synchronization shall be defined as having been achieved when the error rate for the next 1000 bits is 0.050 or less.

3.2.1.3.2 Symbol/Decoder Synchronization Time - For all MAR, SSAR and KSAR coded services, for the minimum data transition density and the minimum C/No required for 10^{-5} P_E performance, the time to achieve joint symbol/decoder/deinterleaver synchronization shall not exceed the following:

a. Biphase symbol formats

(1) 800/data rate (bps) with 90 percent probability
(2) 1,100/data rate (bps) with 99 percent probability

b. NRZ symbol formats

(1) 3500/data rate (bps) with 90 percent probability
(2) 6,500/data rate (bps) with 99 percent probability

3.2.1.3.2.1 S-Shuttle Services - For SSHR services, for the minimum data transition density and the minimum C/No required for 10^{-4} P_E performance, the time to achieve joint symbol/decoder synchronization shall not exceed the following:

a. 1300/data rate (bps) with 90 percent probability
b. 1600/data rate (bps) with 99 percent probability

3.2.1.3.2.1.1 Measurement Time - Symbol synchronization time shall be measured from the time carrier lock signal goes true until the time symbol synchronization is achieved. Symbol synchronization is defined as having been achieved when the error rate for the next 1000 decoded bits is 0.050 or less.

3.2.1.3.3 Symbol/Decoder/Deinterleaver Synchronization Time - For SSA coded and interleaved services, for the minimum data transition density and the minimum C/No required for 10^{-5} P_E performance, the time to achieve joint symbol/decoder/deinterleaver synchronization shall not exceed the following:

a. Rate 1/2 coding:

(1) Biphase symbol format

Average Time :	30,600/data rate (bps)
99 percent probability time :	60,600/data rate (bps)

(2) NRZ symbol formats

Average Time :	36,000/data rate (bps)
99 percent probability time :	66,000/data rate (bps)

b. Rate 1/3 coding

(1) Biphase symbol format

Average Time :	20,600/data rate (bps)
99 percent probability time :	40,600/data rate (bps)

(2) NRZ symbol formats

Average Time :	26,000/data rate (bps)
99 percent probability time :	46,000/data rate (bps)

3.2.1.3.3.1 Measurement Time - Symbol synchronization time shall be measured from the time carrier lock signal goes true until the time symbol synchronization is achieved. Symbol synchronization is defined as having been achieved when the error rate for the next 1000 decoded bits is 0.050 or less.

3.2.1.3.4 Decoder Bypass Symbol Synchronization Time - For all SSA services with the decoder bypassed, for the minimum data transition density and the minimum C/No required for 10^{-5} P_E performance with rate 1/2 coding, the time to achieve symbol synchronization shall not exceed the following:

a. Biphase symbol formats:

300/data rate (bps) with 90 percent probability

b. NRZ symbol formats

3000/data rate (bps) with 90 percent probability

3.2.1.3.1.4.1 Measurement Time - Symbol synchronization time shall be measured from the time carrier lock signal goes true until the time symbol synchronization is achieved. Symbol synchronization is defined as having been achieved when the error rate for the next 1000 uncoded bits is $5x10^{-2}$ or less.

3.2.1.3.5 Channel Lock Time Measurement - The IR shall measure the elapsed time from the receipt of the IR_START_ACQUISITION_COMMAND until the time channel lock is achieved. Channel lock is defined as including carrier, PN, symbol, deinterleaving and decoder synchronization, as applicable to the service configured. For dual channel configurations, the IR shall perform and report the individual I-channel and Q-channel measurements. This measurement shall be performed to the nearest 100 msec.

3.2.1.3.6 Decoder Bypass - Upon command from the SSA control HWCI, the IR shall bypass the decoding operation. The requirement of tables X1X and XX do not apply when Decoder Bypass is in effect.

3.2.1.4 Data Recovery

3.2.1.4.1 Tracking Performance

3.2.1.4.1.1 Mean Time to Cycle Slip - For MAR, KSAR and SSAR non-shuttle services under free-flight dynamics, the mean time between cycle slips in the tracking of the carrier shall be at least 90 minutes for 3 dB less C/No than required for 10^{-5} probability of error provided that the C/No is greater than 27.5 dB-Hz for MAR and SSAR services, and greater than 45 dB-Hz for KSAR services.

For SSHR modes 1 and 2, the above requirement shall be met at 3 dB less C/No than required for a 10^{-4} P_E. Furthermore, for SSHR 3, the mean time to slip shall be at least 90 minutes for a C/No equal to 35.2 dB-Hz or greater.

3.2.1.4.1.2 Mean Time to Bit Slip - Bit slippage requirements shall be met for all MA, SSA and KSA services, with the exception of SSHR, at a reference C/No consistent with that required for 10^{-5} P_E performance. For SSHR, performance shall be met at a reference C/No consistent with that required for 10^{-4} P_E. This requirement shall be met under the jitter and jitter rate conditions as specified in 3.2.1.1.2.5.

a. Normal Transition Density - The mean time to first bit slip in the unit's clock recovery loop shall be no less than 90 minutes, or 10^{+10} clock cycles, whichever is greater, at the reference C/No, and no less than 10^{+6} clock cycles for at 3 dB below this level. This requirement applies for transition densities of at least 40 percent for NRZ symbols and any transition density for biphase symbols.

b. Low Transition Density - For NRZ symbol transition densities between 25 and 40 percent, the mean time to first bit slip shall be no less than 90 minutes, or 10^{+10} clock cycles, whichever is greater, for a C/No 1.0 dB greater than the reference C/No, and greater than 10^{+6} clock cycles for a C/No 2 dB less than the reference level.

3.2.1.4.1.3 Dynamics Tracking - For SSAR services, the IR shall meet the following requirements for tracking a signal with dynamics:

a. Probability of loss-of-lock - The unit shall maintain carrier tracking with a probability of loss-of-lock less than 0.01 over 90 minutes for the input residual frequency dynamics specified in figures 12, 13, and 14.

b. Tracking through transitions - The unit shall maintain carrier tracking with a probability of less than 0.01 during transitions between free and powered flight given an transition time uncertainty of less than 18 seconds. A transition from free-to-powered flight dynamics is characterized as a period, much less than 1 second in length, over which the frequency acceleration greatly exceeds 33 Hz-sec squared. The average frequency rate over the period will be less than 770 Hz/sec. The IR will be notified of an imminent transition via the IR _BURN_ALERT_COMMAND. This command will indicate whether the transition is from free-to-powered or powered-to-free flight dynamics and will also indicate the uncertainty of the transition time.

c. C/No constraints - The above requirements shall be satisfied when the input C/No is as follows:

(1) Equal to that required for a 10^{-5} P_E, or 37.5 dB-Hz which ever is greater, for SSAR DG-1 services.

(2) Equal to that required for a 10^{-5} P_E or 43.6 dB-Hz, whichever is greater, for SSAR DG-2 services.

(3) Equal to that required for a 10^{-4} P_E for SSHR modes 1 and 2.

(4) Equal to or greater than 38.2 dB-Hz for SSHR mode 3

3.2.1.4.2 Ambiguity Resolution

3.2.1.4.2.1 Data Channel Ambiguity - For dual data channel configurations, data channel ambiguity is the uncertainty whether the I-channel or Q-channel data will appear on the designated I- and Q-channel interface port or that they will be reversed. Data channel ambiguity shall be resolved for all data configurations and modes except for DG-2 dual data channel operation with balanced power and balanced rate (QPSK). Specifically, channel ambiguity shall be resolved for the following conditions:

a. Power ratio - I:Q power ratio is 4:1

b. Channel coding - Each channel is coded at a different rate (SSA) or if one channel is coded and one is uncoded (KSA). This requirement does not apply if the decoders are bypassed for both channels (SSA).

c. Channel symbol rates - One channel symbol rate differs by more than 25 percent from the other channel symbol rate.

3.2.1.4.2.2 Data Phase Ambiguity - Data phase ambiguity is the uncertainty whether the logical sense of the data is either true or complemented. For MAR, SSAR and KSAR services, data phase ambiguity shall be resolved for all configurations and modes except when the data format is:

a. NRZ-L for coded operation;
b. NRZ-L or Biphase-L for uncoded operation.

3.2.1.4.2.2.1 S-Shuttle Data Phase Ambiguity - For SSHR services, data phase ambiguity shall be resolved for modes 1 and 2 using the convolutional decoding process.

3.2.1.4.2.3 Data Delay Ambiguity - For any commanded configuration of the unit, the signal processing delay through the unit due to buffering, queuing, clocking, or other processing shall not vary by more than 25 percent of a symbol duration.

3.2.1.4.3 SSA Combining - For SSAR or SSHR services, when configured for SSA combining, the IR shall:

a. Combining delay - Prior to combining, delay the internal symbols relative to the externally provided symbols, as commanded, to ensure synchronization. The IR will be provided with a Combining Delay value as a parameter in the IR_SPECIFIC_CONFIGURATION_COMMAND. This value represents the amount by which the external symbols provided to the IR have been delayed relative to the internal symbols. This delay value will be in the range 0 to 300 nsec, accurate to +/- 40 nsec.

b. Ambiguity resolution - Resolve ambiguity of the externally provided symbols.

c. Independent combining - For quadriphase modulation, perform SSAR combining on the I and Q channels independently.

d. Combining gain - SSAR combining shall be provided such that the probability of error performance of 10^{-5} (10^{-4} for SSHR) can be achieved with a 2.5 dB reduction in C/No at the input to the IR. This requirement applies only when the input symbol jitter and jitter rate are 0.01 percent or less.

e. No improvement - Requirements for acquisition, tracking, and tracking service performance are unchanged by the use of combining (the 2.5 dB performance improvement is not required).

3.2.1.4.4 Autotrack Signal Processing - For all KSAR configurations, the IR shall extract and output the autotrack error term from the I or Q channel with the largest signal-to-noise ratio. In performing this process, the following requirements apply:

a. Predetection SNR - For C/No required for 10^{-5} P_E, the predetection signal-to-noise ratio shall be -6 dB or greater;

b. Transfer characteristics - The transfer characteristics relating the output of the envelope detector to the magnitude of the input signal shall possess the following properties:

   (1) The AC component of the detector output shall be a monotonic increasing function to the input modulation index for index values in the range of 0.2 to 14.0 percent.

   (2) The AC component of the detector output shall be a linear function of the input modulation index for index values in the range 0.1 to 14.0 percent.

c. AC coupled - The detected envelope shall be AC coupled to remove the dc component. The 3 dB point of the coupling response shall be 50 Hz, maximum.

d. Lowpass filtered - The detected envelope shall be lowpass filtered with a 3 dB bandwidth of 4.0 kHz +/- 400 Hz with a rolloff equivalent to 3-pole or better.

e. Output level - The output level of the recovered autotrack envelope shall be linearly proportional to the modulation index at the output of the predetection filter, with a proportionality constant of 100 mV differential, per one percent modulation index.

f. Clipping - Clipping of noise peaks shall be at three standard deviations of the noise, or +/- 12 volts differential, whichever is less.

g. Processing delay - The processing delay from the IF input to the recovered autotrack envelope output shall have an absolute value of 150 usec, maximum, with a delay variation between units and over all data rates and configurations of less than 32 usec.

3.2.1.4.5 Data Processing Delay - For all configurations and channel data rates, the IR's component of the total delay shall not vary by more than 500 nsec, or 5 percent (rms) of the bit period, whichever is greater, over a period of 24 hours. This includes unit to unit variations.

3.2.1.4.6 Channel Error Rate Estimate - The IR shall compute an estimate of the channel error rate (hard decision error rate of pre-decoded symbols) for all configurations using the rate 1/2 and rate 1/3 transparent decoders (not required for SSHR, decoder bypass or uncoded modes). For dual channel configurations, individual I and Q channel error counts shall be computed. The IR shall provide as status, the number of errors counted over the previous one second interval as defined by the 1pps clock epochs.

3.2.1.4.7 IR Interleaving/Deinterleaving - When used, IR Interleaving/Deinterleaving will be per STDN No. 101.2 Appendix J.

3.2.1.5 Tracking Services

3.2.1.5.1 Range Delay Measurement - The IR shall provide range delay measurements when configured for the following modes:

a. MAR DG-1 mode 1
b. SSAR DG-1 mode 1 and 3
c. KSAR DG-1 mode 1 and 3
d. MA, SSA and KSA Range Zero Set
e. MA Calibration

3.2.1.5.1.1 Description

a. The IR shall measure the code state of the received PN code, $C_{IR}(t)$, at every 1 pps mark.

b. The IR shall compute and report the range delay, D(t), at every 1 pps mark based on the measured code state. D(t) is computed as the solution to the implicit equation:

$$C_{IR}(t) = C_{MDP}(t-D(t))$$

where,

$$C_{IR}(t) = C_{MDP}(t-D(t))$$

$C_{MDP}(\tau)$ is the MDP code state at time τ.

c. Range ambiguity shall be resolved by choosing the solution closest to the provided predicted delay, $\hat{D}(t)$.

3.2.1.5.1.2 Random Error - The random error in the range delay measurement shall not exceed the values given below for the data rates indicated, provided the value of C/No at the input to the IR is consistent with a 10^{-5} probability of error.

a.	100 bps to 1000 bps	16 nsec, rms
b.	Greater than 1000 bps	8 nsec, rms

3.2.1.5.1.2.1 Range Zero Set Error - For Range Zero Set, the rms error shall not exceed 2 nsec, provided the minimum C/No is greater than that listed in table XXVIII as per acquisition requirements.

3.2.1.5.1.2.2 MA Calibration Error - For MA Cal, the rms error shall not exceed 16 nanoseconds, provided the minimum C/No is greater than that listed in table XXVIII as per acquisition requirements.

3.2.1.5.1.3 Systematic Error - The residual systematic error contribution to the range delay measurement shall be less than +/- 5 nsec over a 24 hour period.

3.2.1.5.1.4 Reporting - Measured range delay shall be available during the entire period from 300 to 1000 msec following the 1 pps mark at which the measurement was made. All measurements shall be time-tagged with the epoch time.

3.2.1.5.2 Doppler Measurement - Doppler measurements shall be provided for the following one-way and two-way services:

a. One-way Doppler:

(1) SSAR, KSAR and MAR DG-1 Mode 2
(2) SSAR and KSAR DG-2 Mode 2
(3) SSHR Mode 1 and Mode 2, as commanded
(4) KSHR Mode 1

b. Two-way Doppler

(1) SSAR,KSAR and MAR DG-1 Mode 1
(2) SSAR and KSAR DG-1 Mode 3
(3) SSAR and KSAR DG-2 Mode 1
(4) SSHR Mode 1 and Mode 2, as commanded
(5) SSHR mode 3

3.2.1.5.2.1 Description - With $f_{IR}(t)$ denoting the carrier frequency of the IF input as a function of time, then the IR shall compute the Doppler Count, DC(t), where DC(t) is defined as:

$$DC(T) = \int_{t_0}^{t} f_{IR}(U) - f_{ref}(U) \quad du,$$

where,

t_o is the 1pps mark where the counter was last reset, and
fref is the reference frequency as defined below

The IR shall compute and report every second a 1-second average Doppler, delta(kT), which represents the increase in the Doppler count from the last 1 pps mark to the current one. Specifically, the average Doppler is defined as:

$$\Delta(kT) = \left[DC(kT) - \sum_{j=0}^{k-1} \Delta(jT) \right]$$

where,

kT is the time of the kth 1-pps mark, where k=0 corresponds to the last Doppler count reset time
[x] equals the value of x rounded to the nearest millicycle.

The reference frequency is defined differently for coherent and noncoherent services as follows:

1. For coherent services the reference frequency is given by,

$$f_{ref}(t) = R * [f_{MDP}(t - \tilde{D}(t)) + f_{tf}] + f_{trt} + f_{trg}$$

$$+ \dot{\tilde{D}} * R * [f_{MDP}(t - \tilde{D}(t)) - f_{MDPO}]$$

where

$f_{MDP}(\tau)$ is the instantaneous IF carrier frequency transmitted by the MDP at time τ.

R is the coherent turnaround ratio, equal to 1600/1469 for KSAR and 240/221 for SSA and MA

f_{tf} is the zero-motion forward translation frequency, a constant value provided in the IR_COMMON_CONFIGURATION_COMMAND

f_{trg} is the ground station return translation frequency, a constant value provided in the IR_SPECIFIC_CONFIGURATION_COMMAND

$\tilde{D}(t)$ is the IR's best estimate of the round-trip delay. For services which support ranging, $\tilde{D}(t)$ is set equal to $\tilde{D}(t)$, the measured range delay. For other services, $\tilde{D}(t)$ is set equal to the supplied delay profile, adjusted by the unit's best estimate of time bias.

$\dot{\tilde{D}}(t)$ is the IR's estimate of the time derivative of $\tilde{D}$ (t) defined above, and f_{MDPo} is given by,

a. 370.0 MHz + df_F, if the MDP is performing Doppler compensation, where df_F is the forward IF offset frequency

b. $f_{MDP}(t-\tilde{D}(t))$, if the MDP is holding a constant frequency

2. For noncoherent services the reference frequency is given by,

$$f_{ref}(t) = f_{IF} + df_R$$

Where

df_R is the constant component of the frequency profile provided to the IR

f_{IF} is = 370.$\bar{0}$ MHz for SSA & KSA, and = 8.5$\bar{0}$ MHz for MA.

3.2.1.5.2.2 Measurement Error - The rms error of a one second average Doppler frequency measurement shall not exceed the limits specified below. This requirement applies when the C/No is consistent with a 10^{-5} probability of error. This accuracy requirement does not apply during the time the MDP is executing frequency control commands.

Data Rate Range	Allowed Error
100 bps to 500 bps	0.32 rad/sec
500 bps to 1000 bps	0.24 rad/sec
>1000 bps	0.16 rad/sec
SSHR mode 3	0.16 rad/sec

The above allowed error values are in addition to the error introduced by the allowed +/- 25 nsec of uncertainty of the CTFS 1 PPS time reference.

3.2.1.5.2.3 Doppler Count Capacity - The IR shall be capable of accumulating the Doppler count under worst case residual dynamics as specified in table XXVII for at least 50 minutes without destructive overflow.

3.2.1.5.2.4 Doppler Count Reset - The Doppler count shall be automatically reset to zero at the first CTFS 1 PPS mark after entering the tracking state, or under command.

3.2.1.5.2.5 Reporting - The one second average Doppler count measurement shall be available during the entire period from 300 to 1000 msec following the CTFS 1 PPS mark at which the measurement was made. The measurement shall be time-tagged with the CTFS 1 PPS mark time.

3.2.1.5.3 Time Transfer Measurement - In support of Time Transfer measurements, the IR shall measure the time elapsed between each CTFS 1 PPS mark and the occurrence of the next two PN epochs. The IR shall provide this received PN code epoch time measurement for MAR, SSAR, and KSAR DG-1 mode 1 and SSAR and KSAR DG-1 mode 3.

a. Random Error - The rms random error shall not exceed 100 nsec for C/No values corresponding to a 10^{-5} probability of error.

b. Systematic Error - The systematic error in repeated trials of Time Transfer Measurement shall be 10 nanoseconds, with a maximum variation of +/- 10 nanoseconds. That is, measurements may have a positive bias of up to 10 nanoseconds with an additional +/- 10 nanoseconds of error about the bias point.

c. Reporting - The two epoch time measurements shall be available during the entire period from 1300 msec to 2000 msec following the 1pps mark the measurements were made. The time tag on the measurement shall be one second later than the time of the reference 1pps mark.

3.2.1.6 Performance Monitoring - The unit will provide performance monitoring functions in support of operational performance monitoring and to support maintenance. Additional descriptions of these tests are provided in STGT-HE-06-02.

3.2.1.6.1 Confidence Test - The unit shall provide a self-test capability which shall provide initial confidence in the unit. The test shall be run whenever the unit is initially powered up, or when commanded, and shall include the following:

a. Local/remote control - The test shall be initiated upon power up, by local control, or upon remote command.

(1) Local control - The unit shall run Confidence Test when the Reset Switch located on the Maintenance Panel is depressed, regardless of whether the Local/Remote switch is in the Local or Remote position.

(2) Remote Control - When the Local/Remote switch is in the Remote position, the unit shall run Confidence Test upon receipt of the IR_SET_STATE_COMMAND, with the INITIALIZATION TYPE set to RESET.

(3) Local/Remote status - The unit shall provide the status of the local/remote control to the data bus via the IR_PERFORMANCE_REPORT.

(4) Additional status - During Confidence Test, the TEST LED indicator on the front panel will be lit. If Confidence Test fails, the FAULT LIGHT on the front panel will be lit.

(5) Data bus response - While Confidence Test is in progress (the operating state, Confidence Test in Progress), the unit will not respond to data bus commands, or report status.

b. Test groups - The Confidence Test consists of the following test groups:

(1) Test CPU
(2) Test VME
(3) Test Environment
(4) Test Demod ASIC
(5) Test RAM
(6) Test DMDP
(7) Test 1553
(8) Test Indicators

3.2.1.6.1.1 Performance Requirements - The Confidence Test shall:

a. Detect failures - The Confidence Test shall detect hard failures of power supplies and microprocessors for at least 95 percent of all failure modes, weighted for failure rate.

b. Report failures - When a malfunction is detected, data concerning the malfunction shall be entered into temporary storage for later recall by the data bus via the IR_EXTENDED_BIT_REPORT. Extended BIT data will also be available on the unit Front Panel Display.

c. False alarm - The Confidence Test shall have a maximum false alarm rate of one percent.

d. Test time - The time between initiation of the Confidence Test and the availability of test results via the data bus shall not exceed 10 seconds.

3.2.1.6.1.2 Additional Tests - To support maintenance and operation, the unit shall provide On-line BIT Test and Extended BIT Tests.

3.2.1.6.1.2.1 On-Line BIT - Online BIT is a continuous process that is run on all active Integrated Receiver states, which includes the following monitor groups:

a. Monitor synthesizer lock
b. Monitor 1 PPS
c. Monitor environment
d. Monitor time
e. Monitor TMS status

f. Monitor CPU exception
g. Monitor automatic level controls (ALC)

On-line BIT test results shall be provided in the IR_PERFORMANCE_ REPORT and on the Front Panel Display.

3.2.1.6.1.2.2 Extended BIT - Extended BIT is, as its name suggests, a more extended series of built-in tests (BIT) that must be run when the unit is not supporting active user services. This test shall be run remotely in response to the data bus command, IR_SET_STATE_COMMAND, with the INITIALIZATION TYPE set to RUN EXTENDED BIT or in local via command from front panel. Tests include examination of all major components and other least replaceable units (LRUs). Extended BIT results shall be available in the IR_EXTENDED_BIT_ REPORT and on the Front Panel Display. Results of Extended BIT shall provide sufficient data to the subsystem controller such that at least 75 percent of the possible faults identified in FMEA, RMA-O2, can be detected and isolated to an LRU or group of LRUs using solely the BIT results and the isolation logic contained in RMA-02.

3.2.1.6.1.2.3 More Performance Data - To support performance monitoring, and to assist in isolation of malfunctions, the unit provides the following additional data in the IR_PERFORMANCE_REPORT:

a. Error codes - Error codes are provided which provide the reason if the last data bus command was not accepted or executed.

b. Operating state - Several logic states are defined in 3.1.2.2, Operating States. These states are reported and include:

(1) CONFIDENCE TEST IN PROGRESS (not reported)
(2) STANDBY
(3) EXTENDED BIT
(4) CONFIGURATION IN PROGRESS
(5) CONFIGURATION
(6) ACQUISITION
(7) TRACK
(8) REACQUISITION

c. AGC status - Indications of automatic gain control (AGC) will be provided for:

(1) I Coherent Data AGC
(2) Q Coherent Data AGC
(3) 370 MHz IF AGC
(4) 8.5 MHz IF AGC

d. Ephemeris status - To assist the data bus in the transfer of ephemeris data into the unit, an indication, UPDATE COMPLETE, is provided when the ephemeris update has been accepted by the unit.

e. Forward Model status - See STGT-HE-06-02.

f. Receiver Control status - See STGT-HE-06-02.

g. Eb/No estimate - This status report is mandatory and shall be reported to an accuracy of +/- .5 dB for each channel over the range of C/No's specified in 3.2.1.1.2.1.2, Signal to Noise Ratio. This requirement shall only apply when the input noise is Additive White Gaussian Noise (AWGN).

h. Symbol error count - When applicable, the unit will provide symbol error counts from the convolutional decoders.

i. Channel lock time - This status report is mandatory and shall indicate the measured time from IR_START_ACQUISITION_COMMAND until I and Q channel lock. Individual measurements will be provided for each channel. The measurement will report the elapsed time until lock occurs on the applicable channel. When lock occurs, the reported measurements shall be accurate to +/- 20 milliseconds.

3.2.1.6.1.2.4 Details of Performance Reports - Additional details of performance reports are provided in STGT-HE-06-02 of this specification.

3.2.1.7 Operating States - With respect to Operating States, the unit will adhere to the command and response conventions, protocols, messages, and message formats provided in STGT-HE-06-02, Appendix F, Interface Control Document (ICD) for Integrated Receiver - Subsystem Controller/USS ADPE Status and Control 1553B Interface, Section F5.2.4, IR Command and Operating States. To the extent that the ICD does not impose requirements beyond the minimum requirements of 3.1 and 3.2 of this document, the referenced ICD is made a part of STGT-HE-06-02 of this document.

3.2.2 Physical Characteristics

The unit shall be designed to be housed in a standard 19-inch RETMA rack. The unit shall be provided with slide hardware. Overall geometry and arrangement of major components and units shall provide for easy removal and replacement of units and components to minimize equipment maintenance downtime.

3.2.2.1 Dimensions - The dimensions of this unit are as follows:

a. Panel Height -12.22 +0.00, -0.03 in.
b. Panel Width - 18.97 +0.00, -0.03 in.
c. Chassis Depth - 24 in., max.
d. Chassis Width - 17.75 in., max, including slides

3.2.2.2 Weight - The weight of this unit will not exceed 85 pounds.

3.2.3 Reliability

The unit shall have a minimum Mean Time Between Failure (MTBF) goal of 2500 hours when operated in a fixed environmentally controlled area. The MTBF will be calculated using an average temperature of 75 degrees F.

3.2.3.1 Mean Time Between Failures - The MTBF requirements shall apply to the unit while being maintained in accordance with 3.2.4, and during exposure to the environments of 3.2.5. The MTBF shall be analyzed using failure rates based on MIL-HDBK-217, or other sources that are approved by the procuring activity. In order to achieve the required MTBF, the reliability program provisions of STDN 927.4, Section 6 shall apply.

3.2.3.2 Design Life - The unit shall be designed for a lifetime of ten (10) years of continuous operation, not including administrative periods of non-operation, or downtime for maintenance, as specified in 3.2.4 .

3.2.3.3 Acoustical Noise - The acoustical noise level, with all fans and/or blowers on, shall be in accordance with MIL-STD-1472 paragraph 5.8.3.1 and 5.8.3.3.2.

3.2.4 Maintainability

The unit shall meet the maintainability requirements as defined in the following paragraphs.

3.2.4.1 On-Line Replacement - The unit shall be designed to support in-circuit repair or system restoration as defined in 3.5 by fault isolation, disassembly, failed item removal and replacement, reassembly, and test of the replaced unit at the line replaceable unit (LRU) level.

3.2.4.1.1 LRU Level Definition - The line replaceable unit level for the unit is board/module, or the unit in its entirety. LRU's shall incorporate status indicators along with test and monitoring points as appropriate to allow test via Maintenance Test Group (MTG) test equipment.

3.2.4.2 Mean Time To Repair (MTTR) - The unit shall be designed such that the mean time to achieve on-line repair, including isolation, removal, replacement, and retest of the LRU shall not exceed 25 minutes. In order to demonstrate achievement of the required MTTR, the maintainability verification provisions of STDN No. 927.2, Section 4.4.1.3 shall apply. Logistics time to obtain parts or test equipment is excluded.

3.2.4.3 Maximum Time To Repair (MTR) - The maximum time to effect on-line repair, as defined in 3.5.1.3, shall not exceed one hour for the 90th percentile of failures.

3.2.5 Environmental Conditions

3.2.5.1 Nonoperating Environments - This unit shall suffer no permanent degradation or damage when subjected to the following environments:

a. Temperature - From -20 to 160 degrees F.
b. Humidity - 0 to 100 percent relative humidity, non-condensing environment.
c. Altitude - Sea Level to 35,000 feet.
d. Solar Radiation - 350 BTU/ft^2/hour

3.2.5.2 Operating Environments - This unit shall meet all specified performance requirements while exposed to the following environments:

a. Temperature - From 50 to 100 degrees F.
b. Humidity - From 20 to 80 percent without condensation
c. Altitude - Sea Level to 12,000 feet

3.2.6 Transportability
The equipment shall be capable of shipment by ship, truck, rail, and air transport.

3.3 DESIGN AND CONSTRUCTION
Design and construction requirements shall be in accordance with MIL-STD-454 Guidelines, except as specified herein. Commercial equipment such as computers and their peripherals, test equipment, single-board computer boards, and compatible Input/Output (I/O) boards, etc., that meet the performance requirements for use on the program shall be exempt from these requirements.

3.3.1 Materials, Processes, and Parts

3.3.1.1 Materials - Corrosion-resisting materials and finishes shall be used to the maximum extent. Metal-to-metal contact of dissimilar metals shall be governed by the criteria of MIL-E-16400. Fungus nutrient materials, mercury, and radioactive material shall not be used in any form.

3.3.1.2 Standard and Non-Standard Parts and Materials - Parts and Materials shall be selected and fabricated or assembled in such a manner that they conform to these specifications. Non-standard parts and materials as defined shall be used only with the approval of GE Contracts Administration.

3.3.1.2.1 Standard Parts and Materials - Standard parts and materials shall be those specified by any of the following:

a. A published government qualified products list.

b. Mil-Std-975 Grade 2.

c. Commercial specifications certified by the vendor to meet industry specifications and standards as those promulgated by nationally recognized associations, and technical societies as having coordinated status with the government requiring activities.

d. Commercial parts certified by the vendor to meet industry specifications and standards having limited coordination status with the government requiring activities.

3.3.1.2.2 Non-Standard Parts and Materials - Non-standard parts and materials are defined as those being:

a. Selected parts, or those whose performance and physical characteristics are unique when compared with vendor stocked or cataloged items and which cannot be ordered by standard nomenclature only.

b. Any parts and materials not covered by the standard parts and materials definition.

3.3.1.2.3 Standard Components - Standard commercial components shall be employed throughout, to the greatest extent practicable. Sole source components shall be held to a minimum. Unless approved by the GE Contracts Administration, specified performance of the equipment shall be obtained without selection of components whose performance and physical characteristics are unique when compared with vendor stocked or cataloged items and which cannot be ordered by standard nomenclature only.

3.3.1.2.4 Programmable Devices - A firmware document shall be prepared for each unit design requiring firmware. Programmable devices shall be clearly marked and identified.

3.3.1.3 Surface Treatment - All aluminum surfaces shall be chemical-film-treated (iridited) per MIL-C-5541 (Class 3), or MIL-P-53030 Primer before painting. All front panel to cabinet mating surfaces shall be free of paint. Stainless-steel surfaces shall be passivated per MIL-S-5002. Class 1 iridite is permissible when undergoing touch up work.

3.3.1.4 Paint - Panel front and edges, and surfaces exposed when the unit is mounted, shall be painted semigloss gray, Color Chip 26440, per FED-STD-595, with a low volatile organic compound (VOC) polyurethane finish (Cardinal 6400 series). Panel lettering shall be semigloss black chip number 27038.

3.3.1.5 Electrical Grounding and Bonding - Bonding and grounding shall be in accordance with GSFC STDN 270.7. MIL-HDBK-419 shall be used as a reference document. The unit shall have a ground lug located on the rear of the chassis. The lug size shall be either 8/32 or 10/32. The lug (E101) shall provide a ground for the unit.

3.3.1.6 Electrostatic Discharge Protection - Units containing Electrostatic Discharge Sensitive (ESD) devices shall be marked with ESD sensitive device caution labels.

3.3.1.7 Electrical Design

3.3.1.7.1 Electrical Connections

3.3.1.7.1.1 Attachment of Wires and Leads - The equipment shall conform to MIL-STD-454, Requirement 19.

3.3.1.7.1.2 Solderless Wrap - The attachment of wires by solderless wrapping shall conform to MIL-STD-1130.

3.3.1.7.1.3 Soldered Connections - The attachment of wires and leads shall conform to MIL-STD-454, Requirement 5, except resin flux conforming to type RA of QQ-S-571 may be used for electrical and electronic connections. Electrical interconnections and harnesses shall be in accordance with MIL-STD-454 requirements 69 and 71.

3.3.1.7.2 Electrical/Electronic Parts - Electrical/electronic parts shall be selected in accordance with sound engineering practices and in support of the requirements of paragraph 3.2.3. Unless the specific application dictates otherwise, parts shall be of "best commercial quality."

3.3.1.7.3 Electrical Power - The equipment shall operate from the power specified herein.

3.3.1.7.3.1 Single-Phase Power - The unit shall be designed to operate from a two-wire, plus ground, source of 120 volts. The AC power system neutral shall not be connected to the chassis under any circumstances.

3.3.1.7.3.2 Power Transient Susceptibility - Power system transients of as much as a ± 10 percent change from the nominal voltage for a period of up to 10 percent of the nominal line frequency will not deteriorate performance of the system. Power transients of a ± 10 percent change from the nominal voltage lasting for two (2) seconds shall not prevent satisfactory operation of the equipment immediately following the transient period. Sudden loss of power or prolonged transients of the above type will not damage the equipment.

3.3.1.7.3.3 Overload Protection

a. Electrical overload protection shall meet MIL-STD-454, Requirement 8.

b. A fuse or an overcurrent trip unit of a circuit breaker shall be connected in series with each ungrounded power conductor as determined by the National Electric Code, NFPA 70, for grounded source power.

c. The overcurrent device shall be connected to the line side of the power switch.

3.3.1.7.3.4 Primary Circuit Fuses - There are no primary circuit fuses in this unit.

3.3.1.7.3.5 Circuit Breakers

a. When circuit breakers are used, the restoring or switching device shall be readily accessible to the operator.

b. The circuit breaker shall give a visual indication when the breaker is tripped.

c. Holding the switching device closed on an overload shall not prevent tripping of the breaker.

d. Circuit breakers may be mounted on the rear panel and used as on/off switches.

e. Circuit breakers for DC and single-phase AC applications shall conform MIL-C-39019 or commercial equivalent.

3.3.1.7.4 Printed Wiring - Printed wiring shall meet the requirements of MIL-STD-454, Requirement 17. Conformal coating shall not be applied to the printed-wiring assembles.

3.3.1.7.5 Single or Double-Sided Printed Wiring Boards - Single or double-sided printed wiring boards shall conform to MIL-P-55110.

3.3.1.7.6 Multilayer Printed Wiring Boards - Multilayer printed wiring boards shall conform to MIL-P-55110.

3.3.1.7.7 Preferred Circuits

a. In the interest of standardization of circuits, use of standards parts and, ultimately, the collection of circuit performance reliability data, circuits shall be selected whose performance is based on parameters of the parts which are controlled by specification.

b. Conversely, circuit performance shall not be dependent on uncontrolled parameters.

c. Selected circuits shall be such that the use of parts having an approximately normal distribution for those characteristics which are important to the individual applications results in the required equipment performance.

3.3.1.8 Mechanical Design

3.3.1.8.1 Accessibility - Access to enclosures shall be in accordance with MIL-STD-454, Requirement 36.

3.3.1.8.2 Structural Integrity - The unit shall be designed to withstand stresses associated with the transportation, installation, operation, and maintenance of the unit.

3.3.1.8.3 Captive Hardware - Captive hardware shall be used to secure any panel or module which normally would be opened or removed as part of a normal maintenance action.

3.3.1.9 Thermal Design - Thermal design shall be in accordance with Requirement 52 of MIL-STD-454.

3.3.2 Electromagnetic Interference (EMI)
The unit shall meet the following EMI requirements at the rack level:

a. CE-03, Radio Frequency Power Line Conducted Emissions - FCC Class A Limits. Appropriate power line filtering shall be used to satisfy the conducted emission and susceptibility requirements.

b. CE-07, Conducted Switching Spikes - MIL-STD-461 reduced to 5 percent of the line voltage during steady state operation and 50% at turn on and turn off.

c. CS-01, Audio Frequency Power Lead Conducted Susceptibility (30 Hz - 50 kHz) - MIL-STD-461 reduced to 2.5 volts rms from 30 Hz to 13 kHz, then following a straight line to 1.0 volt rms at 50 kHz.

d. CS-02, Radio Frequency Power Line Conducted Susceptibility (.05 to 50 MHz) - MIL-STD-461 reduced to 0.1 volts rms.

e. CS-06, Conducted Spike Susceptibility - MIL-STD-461 reduced to 100 volts peak at 10 microseconds pulse width.

f. RE-02, Radiated Emissions, Electric Field - FCC Class A limit extended down to 15 kHz from 30 MHz, and extended to 10 GHz from 1 GHz with a reduced limit of 20 dBuv/M (measured at 1 meter) from 2.1 to 2.3 GHz. The RE-02 limits specified are granted an additional 20 dB relief due to anticipated rack attenuation.

g. RS-02, Radiated Susceptibility, Magnetic Induction Field, Spikes and Power Frequencies - MIL-STD-461 except reduce the spike voltage to 100 volts peak and power line current (60 Hz) to 2.0 amps.

h. RS-03, Radiated Susceptibility, Electric Fields - MIL-STD-461 except reduce the R.F. field intensity to 0.5 volt/meter from 14 kHz to 2.6 GHz. The R.F. signal will be amplitude modulated, 50 percent at 400 Hz or 1000 Hz.

3.3.2.1 EMI Development Testing - EMI testing shall include development tests of selected components demonstrating potential problems areas. Development tests or analysis, or both shall be performed to gather and verify the characteristics of the identified potential problem areas. EMI tests shall conform with the methods of MIL-STD-462.

3.3.3 Nameplates and Product Marking
A unit nameplate shall be securely attached to the unit. The identifying nameplates shall be in accordance with requirement 67 of MIL-STD-454. The equipment shall be marked with an identifying number in accordance with MIL-STD-130. Electrical parts shall be labeled with designators where necessary to permit ease of identification and shall be uniform throughout the equipment in accordance with requirement 67 of MIL-STD-454. The CAGE Code shall be used in the identification of the equipment. Commercial equipment shall be identified using vendor's standard practices. Front panel legends shall conform to the criteria of paragraph 5.5 of MIL-STD-1472.

3.3.3.1 Location - The general location for the nameplate shall be not more than 6 in. behind the front panel. The preferred location is on the right side panel as one views the front to the rear of the unit.

3.3.4 Workmanship
Workmanship of equipment specified herein shall conform to requirement 9 of MIL-STD-454.

3.3.5 Interchangeability/Producibility

3.3.5.1 Interchangeability - Mechanical and electrical interchangeability shall exist between like assemblies, subassemblies, and replaceable parts regardless of the manufacturer or supplier. The equipment shall be so designed that:

a. Cards and modules normally replaced as part of a maintenance action shall be plug-in design.

b. Replacement of a faulty card and module shall not require the removal of any other card or module.

c. Items with the same identifying part number shall be physically, electrically, and functionally interchangeable.

d. Physically similar, but functionally different cards and modules shall be physically keyed to prevent inadvertent erroneous installation.

e. No card or module replaced as a normal maintenance action shall require alignment or adjustment in the equipment when the replacement is performed, except for power supplies.

3.3.5.2 Producibility - The design shall incorporate features which allow for cost effective production. In this regard, the design shall:

a. Use common materials and processes.
b. Select designs such that automated processes can be used for fabrication.
c. Use multiple sources of supply wherever possible.
d. Use subcontractor standard fabrication, assembly test, and inspection procedures.

3.3.6 Safety
Equipment design shall conform to MIL-STD-454, Requirement 1.

3.3.6.1 Leakage Current - The AC leakage current shall not exceed 5 milliamps, rms, measured at the units input AC Power Safety Ground.

3.3.6.2 Power Supply Protection - Fault conditions ranging from open circuits to short circuits shall cause no damage to the power supply.

3.3.6.3 Equipment Electrical Power On-Off Switch

a. A switch for disconnecting the unit from all electrical power systems shall be mounted on the equipment front panel and its function shall be clearly labeled.

b. A locking type power on-off switch shall break all power conductors of the power circuit.

3.3.6.3.1 Printed Circuit Assembly Protection - Transient Suppression as well as capacitive decoupling shall be provided on all printed circuit assemblies.

3.3.6.4 Power Indicator - A power indicator shall be connected to the load side of the power switch, across the input power conductors, to indicate that the unit is energized.

3.3.6.5 Electrical Cable Protection - Equipment design shall preclude damage to electrical cabling during all normal conditions of assembly, removal, and insertion of equipment when performed by skilled maintenance personnel.

3.3.6.6 Support Strength

a. Slides, detents, mounting surfaces and other attachment mechanisms which support equipment shall have a safety factor equal to twice the maximum anticipated load.

b. Drawer slide design shall include provisions to prevent accidental derailing and detachment of equipment from the shelter.

3.3.6.7 Equipment Access

a. Hinged covers, and sides shall have automatic latch/quick release devices which must be actuated before they can be opened.

b. Sufficient clearance shall be provided in each maintenance configuration to allow tasks to be performed without undue physical discomfort, danger, or effort.

3.3.6.8 Critical Controls - Critical controls, the accidental activation of which may cause damage to equipment, injury to personnel or degradation of system function, shall be designed and located so that they are not susceptible of being accidentally activated.

3.3.6.9 Human Error Design Protection - Operator panel control functions shall be designed in such a manner that neither incorrect adjustment nor random sequencing of functions will cause damage to the equipment.

3.3.6.10 Unacceptable Materials - Equipment design shall not include polychlorinated biphenyls (PCBs), asbestos and asbestos compounds, fragile or brittle materials, beryllium and beryllium compounds unless so identified, and lithium and lithium compounds not specifically approved by the procuring agency.

3.3.6.11 Test Circuit Protection - The maintenance panel and front panel test interfaces shall be suitably protected to prevent equipment damage or personnel hazard during maintenance operations.

3.3.7 Human Performance/Human Engineering

Human engineering design criteria and principles shall be applied in equipment design so as to achieve safe, reliable, and effective performance by the operator and maintenance and control personnel. The guidelines of MIL-STD-1472 shall be used as the criteria for human engineering design.

3.4 DOCUMENTATION

The plan for prime item documentation is provided in CC Document No. C901E3331, Configuration Management Plan and Procedures for the Second TDRSS Ground Terminal, also known as IEC CM-01/02.

3.5 LOGISTICS

The unit and its major items shall be designed to include provisions for maintenance in compliance with the reliability, maintainability, and interchangeability requirements of 3.2.3, 3.2.4, 3.3.5 and the concepts and criteria described in the following paragraphs.

3.5.1 Maintenance

3.5.1.1 Adjustments - There shall be no maintenance adjustments on this unit except for power supply voltage level settings.

3.5.1.2 Special Support Equipment - During fault isolation, the Performance Measuring and Monitoring Equipment (PMME) and/or the Maintenance Test Group (MTG) may be required.

3.5.1.3 First Level Maintenance - First level maintenance shall consist of fault detection, fault isolation, including isolation capabilities available with built-in-test on line analysis, front panel control, and MTG indicators/test points, followed by removal and replacement of the failed item, reassembly and verification to assure that the system has been restored to operational status. Items replaced during first level maintenance shall be consistent with the line replaceable unit (LRU) concept defined in 3.2.4.1.1.

3.5.1.3.1 Fault Isolation Performance Requirements - The mean time to isolate to an LRU, replacement, and repair inclusive of verification is 25 minutes. The average time to remove and replace an LRU shall not exceed 10 minutes.

3.5.1.3.2 In-Circuit Preventive Maintenance - Preventive maintenance shall be capable of being performed on-line without impeding the operational usage of the unit. Preventive maintenance shall take place with the unit in-place and shall not restrict the usage of the unit for periods greater than 1 hour per month.

3.5.1.4 Off-Line Maintenance, Second Level Maintenance - Second level maintenance shall include all repair of failed units or preventive maintenance which is not to be performed in-circuit. Second level maintenance of defective LRU's is normally performed by the vendor's depot facility.

3.6 Personnel and Training
Refer to CCD # C903F3379.

3.7 Major Component Characteristics
The functional, performance and physical requirements and characteristics of each major component of this unit are given in the performance specifications referenced in IEC drawing number 7472102.

3.8 Precedence
The order of precedence with respect to the requirements specified in this document is:

(1) This specification, 7472106;

(2) The General Electric specifications as traced in the Traceability Matrix of Appendix III of this document.

(3) SOW-GE-STGT-8701, Statement of Work (SOW) for USS SSA Equipment HWCI, KSAR Low Data Rate Equipment HWCI, MA RCVR/XMTR Equipment HWCI. Revision 5, 28 November 1989.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

This section defines the requirements for verification of performance and design characteristics specified in Section 3 of this specification. The subcontractor is required to implement and maintain a Quality Assurance (QA) Program in accordance with the SOW. In the event of conflict between this specification and the SOW, the SOW takes precedence. This program applies to all work accomplished by the subcontractors and suppliers, including subtier sources and other divisions or subsidiaries of the subcontractor (hereafter termed subcontractor) who provide parts, materials, components, systems, and software as described in the contract Statement of Work.

The subcontract shall verify that his procurement documents impose the applicable section of this document on his subcontractors and other suppliers. These subcontractors and other suppliers shall, in turn impose these standards on their procurement sources.

Verification will include:

a. Inspection (in-coming, in-process and final)
b. Tests
c. Demonstration
d. Analysis

4.1.1 Responsibility for Verifications

Unless otherwise specified in the contract or order, the subcontractor is responsible for the performance of all verification requirements as specified herein. Except as otherwise specified, the subcontractor may utilize his own facilities or any commercial laboratory acceptable to GE. GE reserves the right to perform any of the verifications set forth in the specification where such verifications are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1.1 Quality Assurance Requirement - Quality assurance requirements shall be in conformance with the Statement of Work (SOW).

4.2 QUALITY CONFORMANCE VERIFICATIONS

Appendix IV defines the method of verification (test, inspection, demonstration, analysis) for each requirement specified in Section 3. All testing shall be performed using calibrated test instrumentation. All data taken during the verification test shall be validated by the subcontractor QA personnel and made available to the GE and NASA QA representative.

4.2.1 Test

Tests identified in Appendix IV shall be performed to verify that the hardware conforms to the operational parameters as defined in the applicable paragraph of Section 3. All verification testing shall be performed at ambient conditions. No environmental tests are required.

4.2.2 Inspections

Inspections shall be in accordance with subcontractor's STGT Quality Assurance Plan. Inspections are visual investigations of design, production, or test documentation, or the observation/measurement of hardware/software characteristics to determine compliance with specified requirements. Requirements of Section 3 that are satisfied by inspection are identified in Appendix IV.

4.2.3 Demonstration

Demonstrations are the exercise of hardware/software operations to assure that special qualitative functions and capabilities can be performed in accordance with applicable specifications.

4.2.4 Analysis
Where applicable, the verification of some technical parameters and performance will be accomplished by analysis. Analysis is the mathematical treatment including computer analysis of appropriate models to determine compliance with specified requirements where test, demonstration and inspection are not feasible. Analysis may be performed with as-built test results or as-built data to provide formal verification of a requirement. Analysis shall be documented in SDRL Supporting Engineering Analysis and Data (HE-08).

4.2.5 Method Annotation
An X is placed in the applicable column of Appendix IV to mark the verification method for each requirement.

Where an X(P) is placed in one column of Appendix IV and an X(S) is placed in one or more of the other columns, this means that the method marked X(P) is the primary verification method, but it must use supporting data gathered from the results of the other methods. An X is placed in the N/A column for Non-Applicable or Non-Requirements such as summary or introductory paragraphs.

5.0 PREPARATION FOR DELIVERY

Preparation for delivery shall be in accordance with NHB-6000.1C. No non-standard practices are required.

6.0 NOTES

No additional notes or instructions are required.

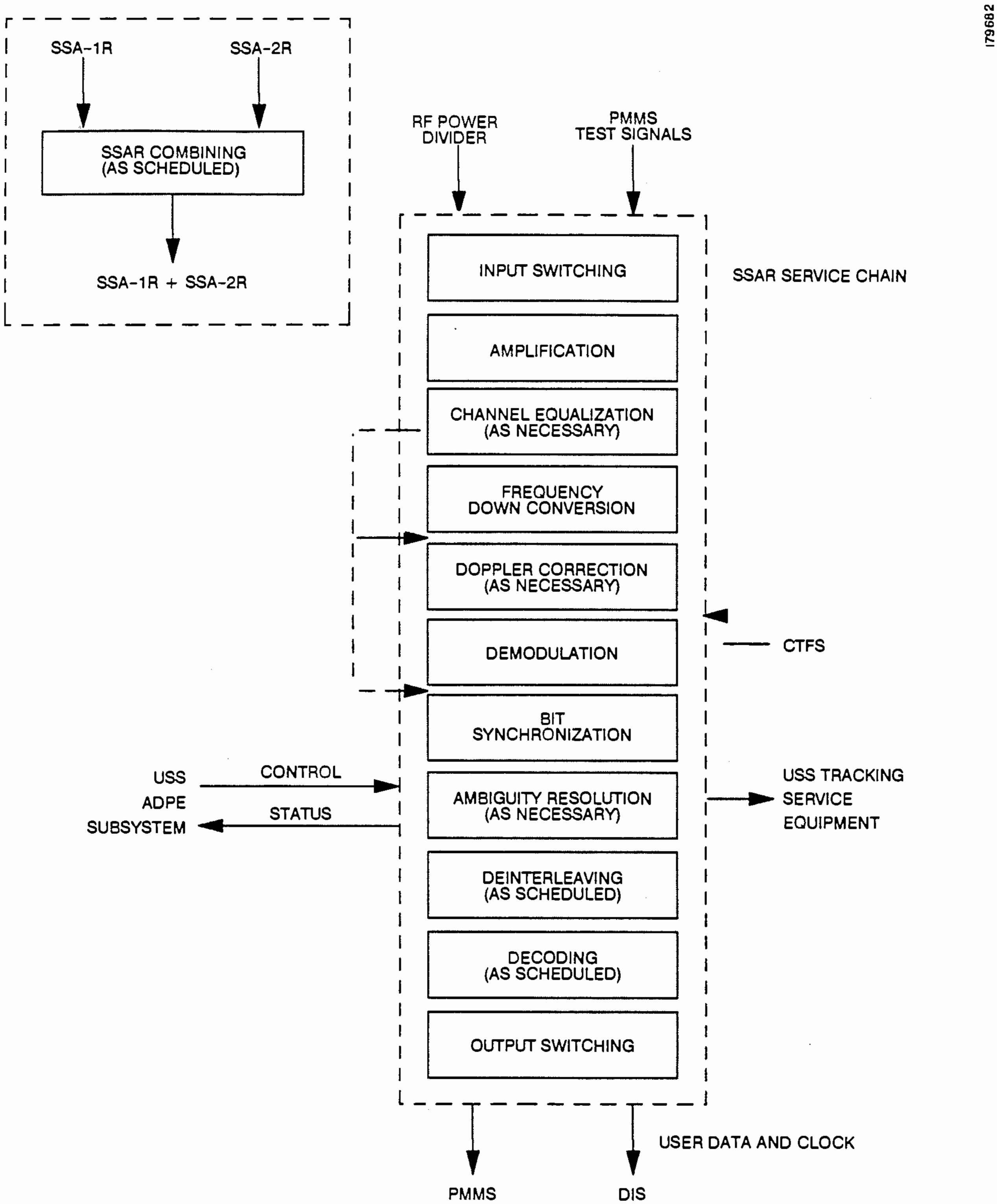

Figure 1. SSA Return Service Chain

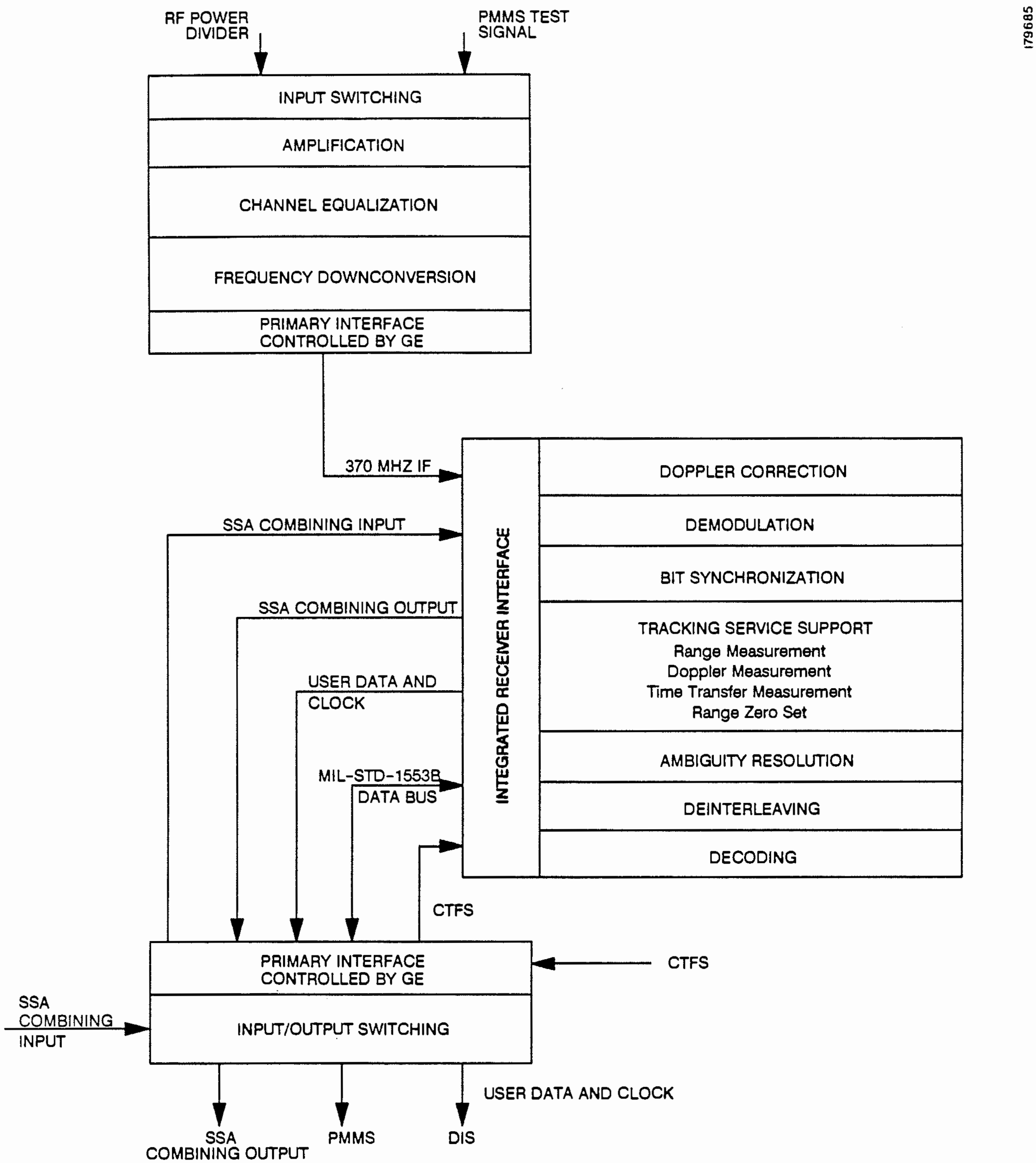

Figure 2. Integrator Receiver Unit Functions (SSAR)

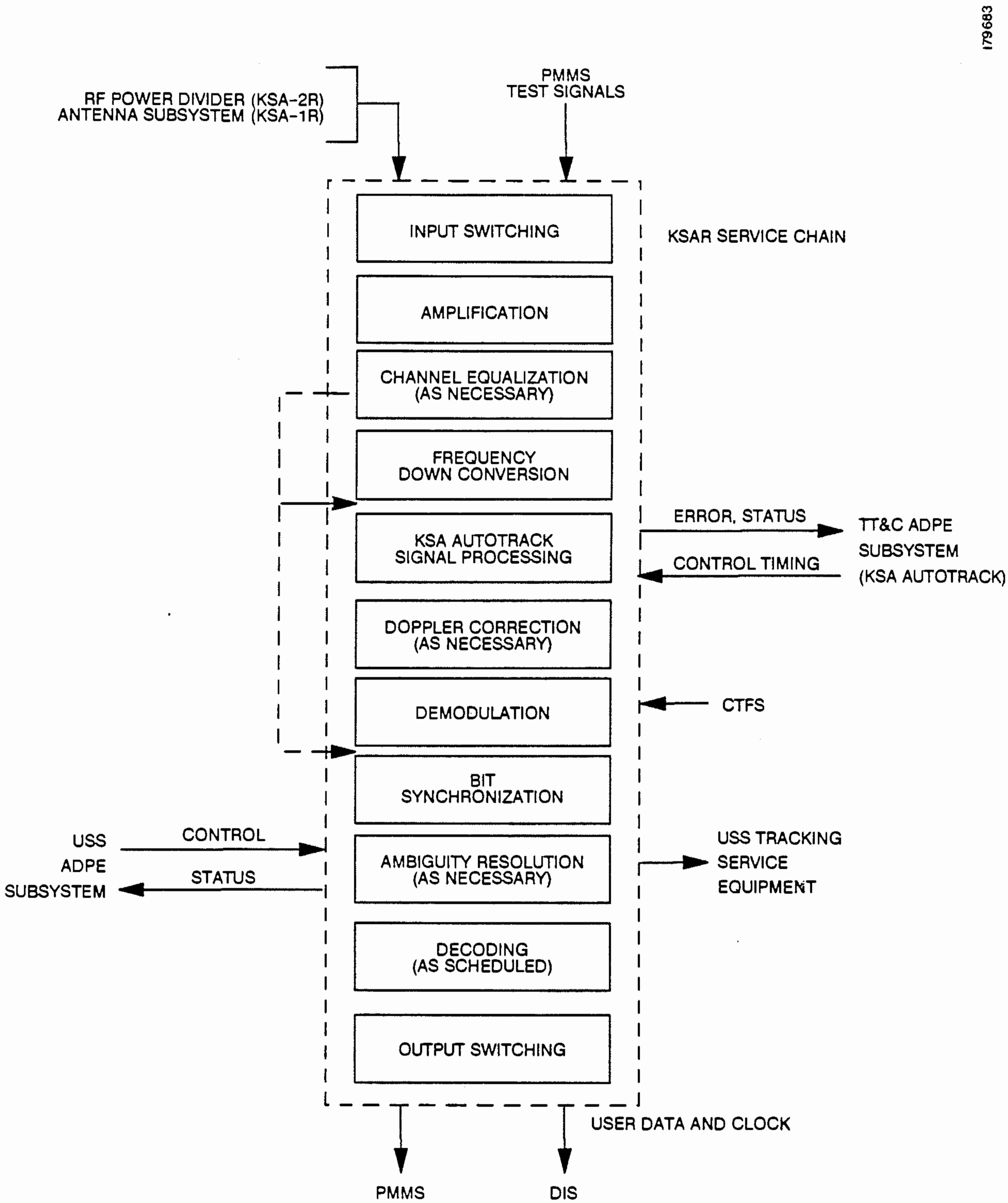

Figure 3. KSA Return Service Chain

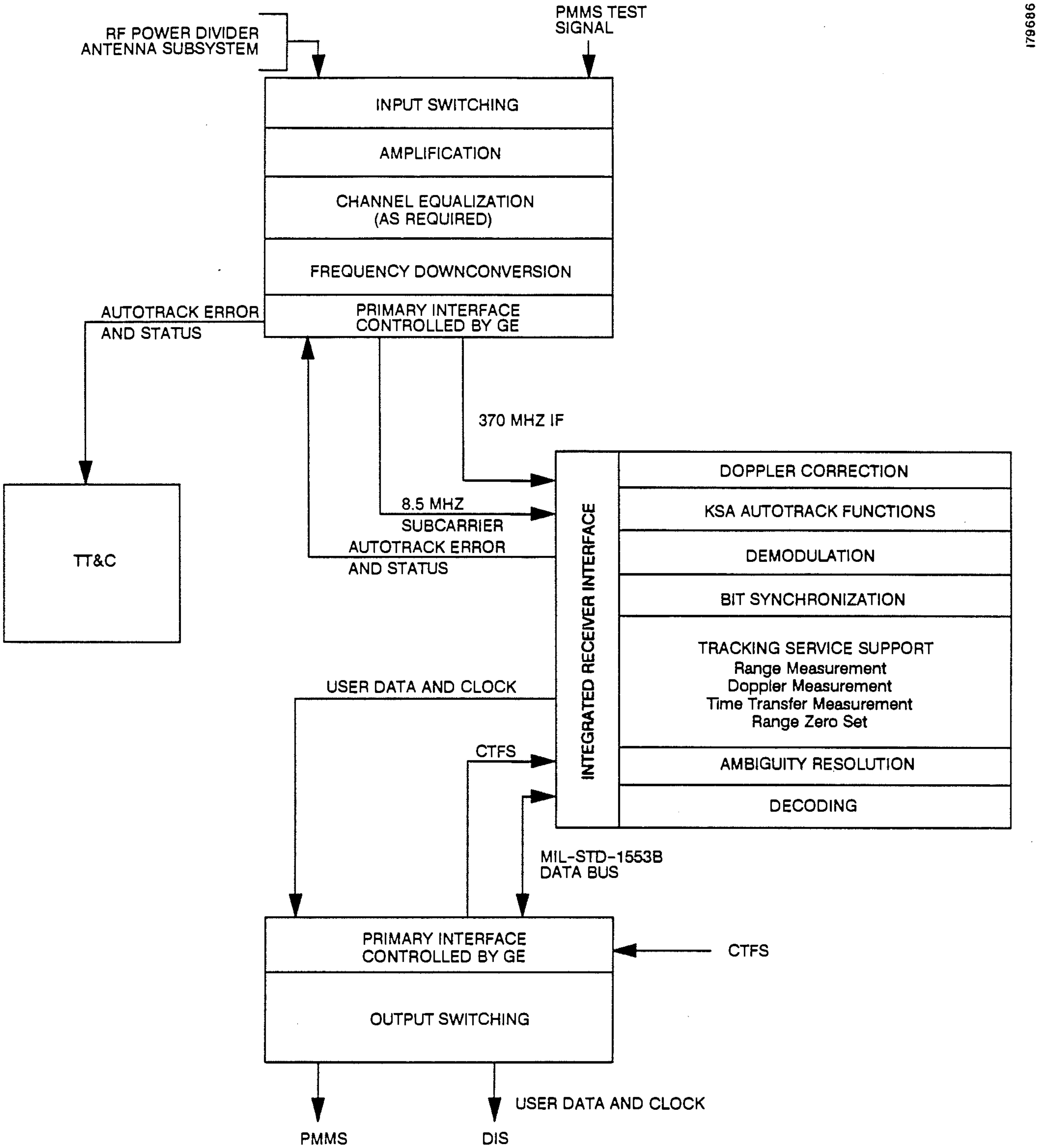

Figure 4. Integrated Receiver Unit Functions (KSAR)

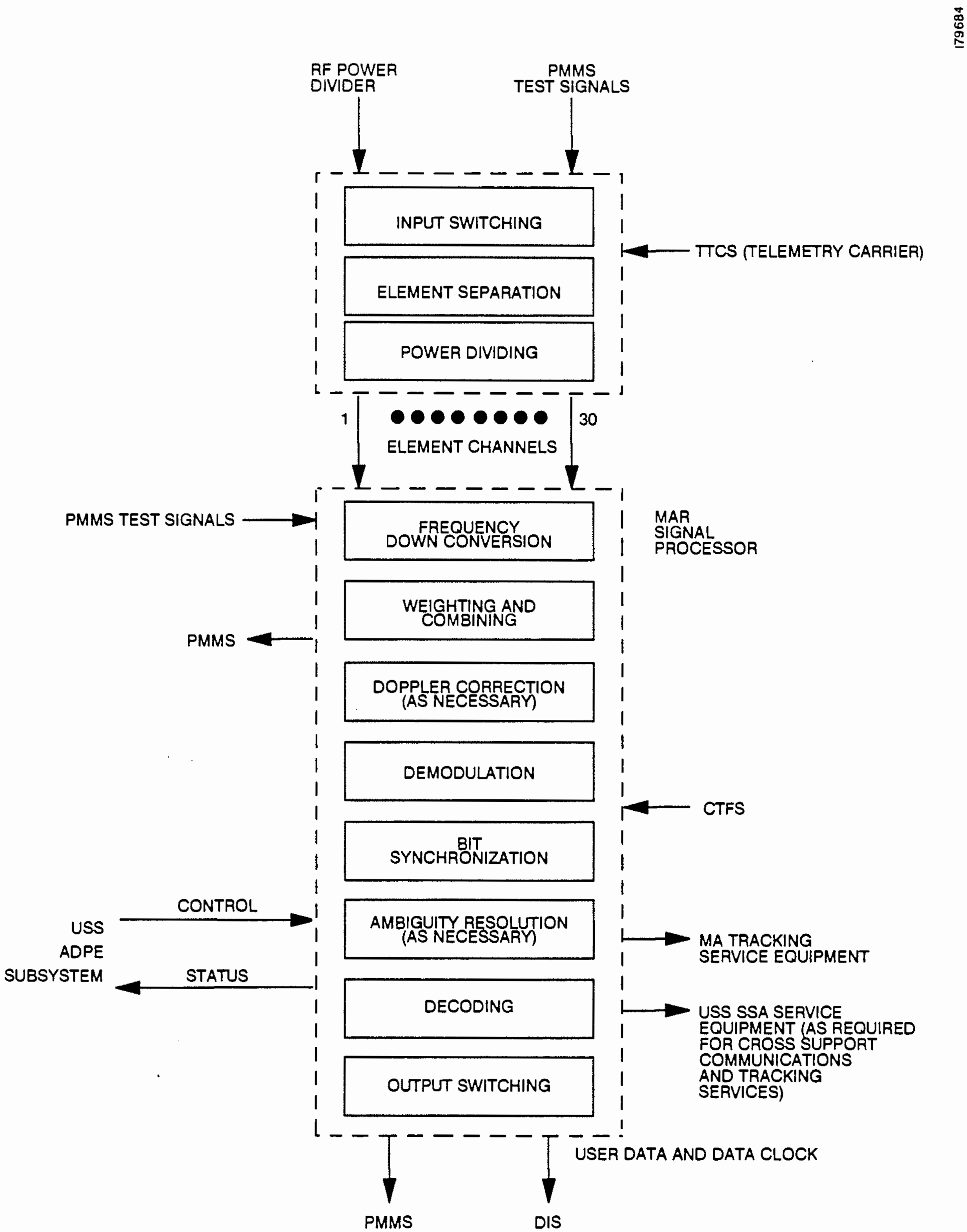

Figure 5. MA Return Service Chain

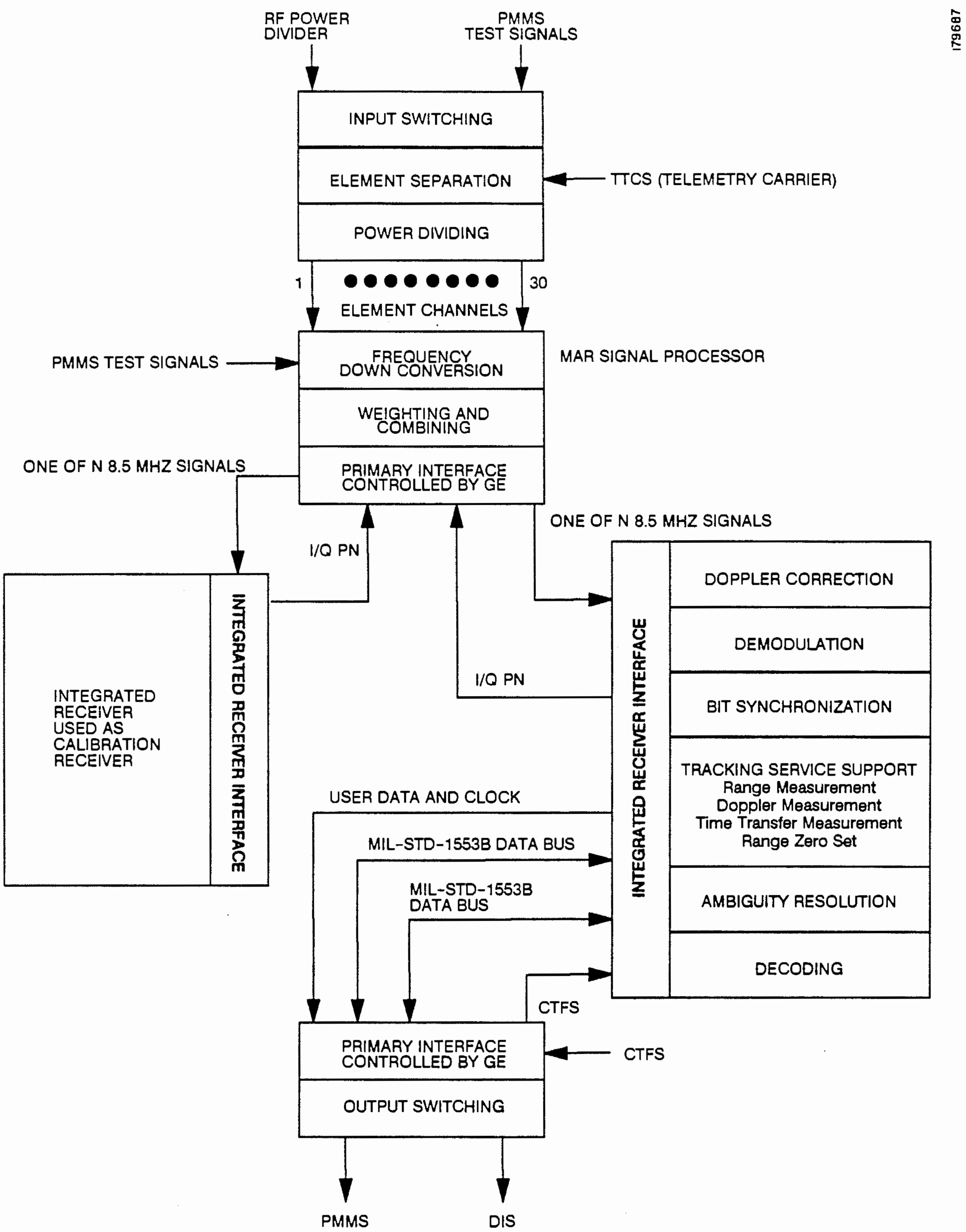

Figure 6. Integrated Receiver Unit Functions (MAR)

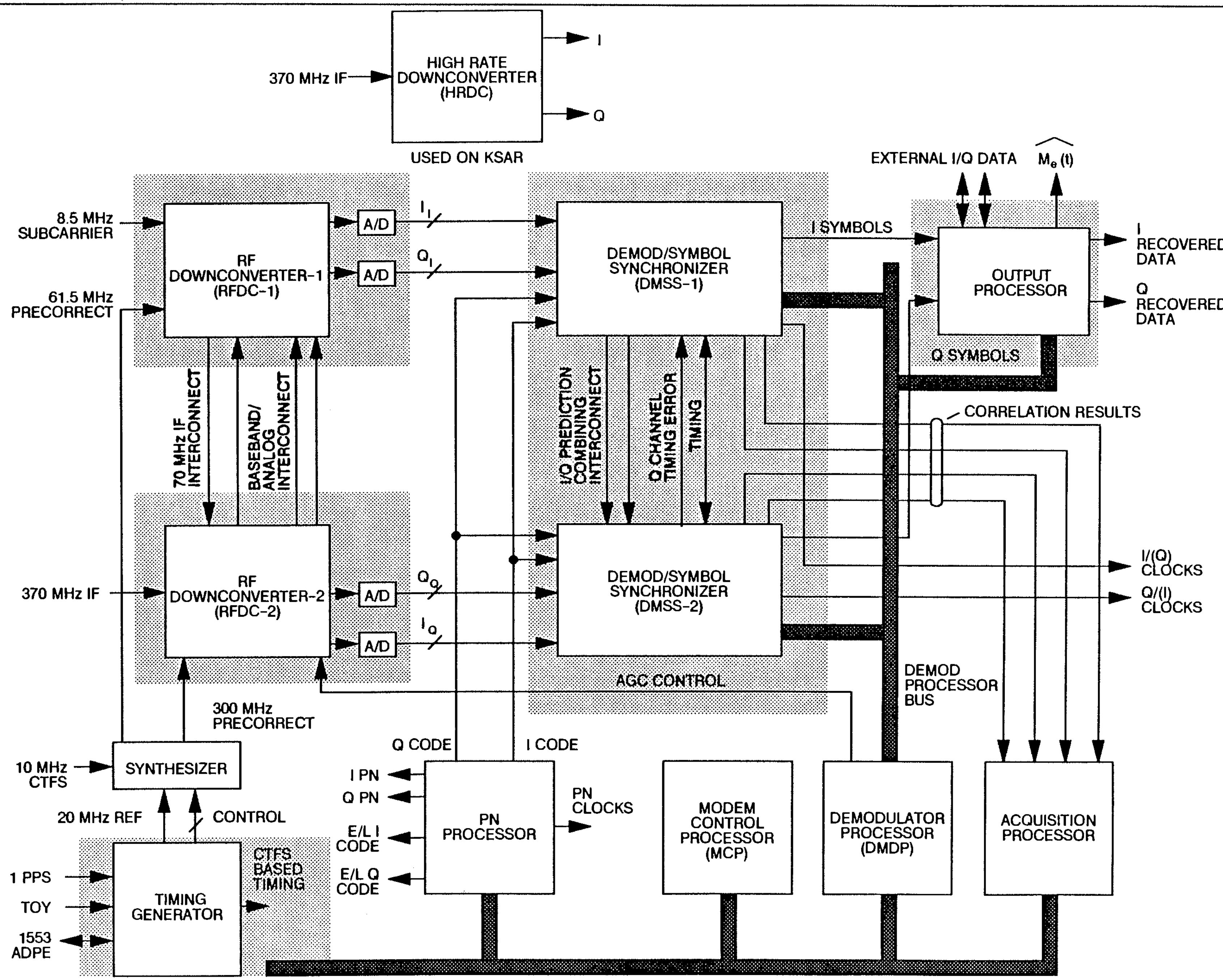

Figure 7. Major Components for Integrated Receiver

INTERSTATE ELECTRONICS CORPORATION A Figgie International Company	SHEET NUMBER	DOCUMENT NUMBER	REV
	F-7	7472106	C

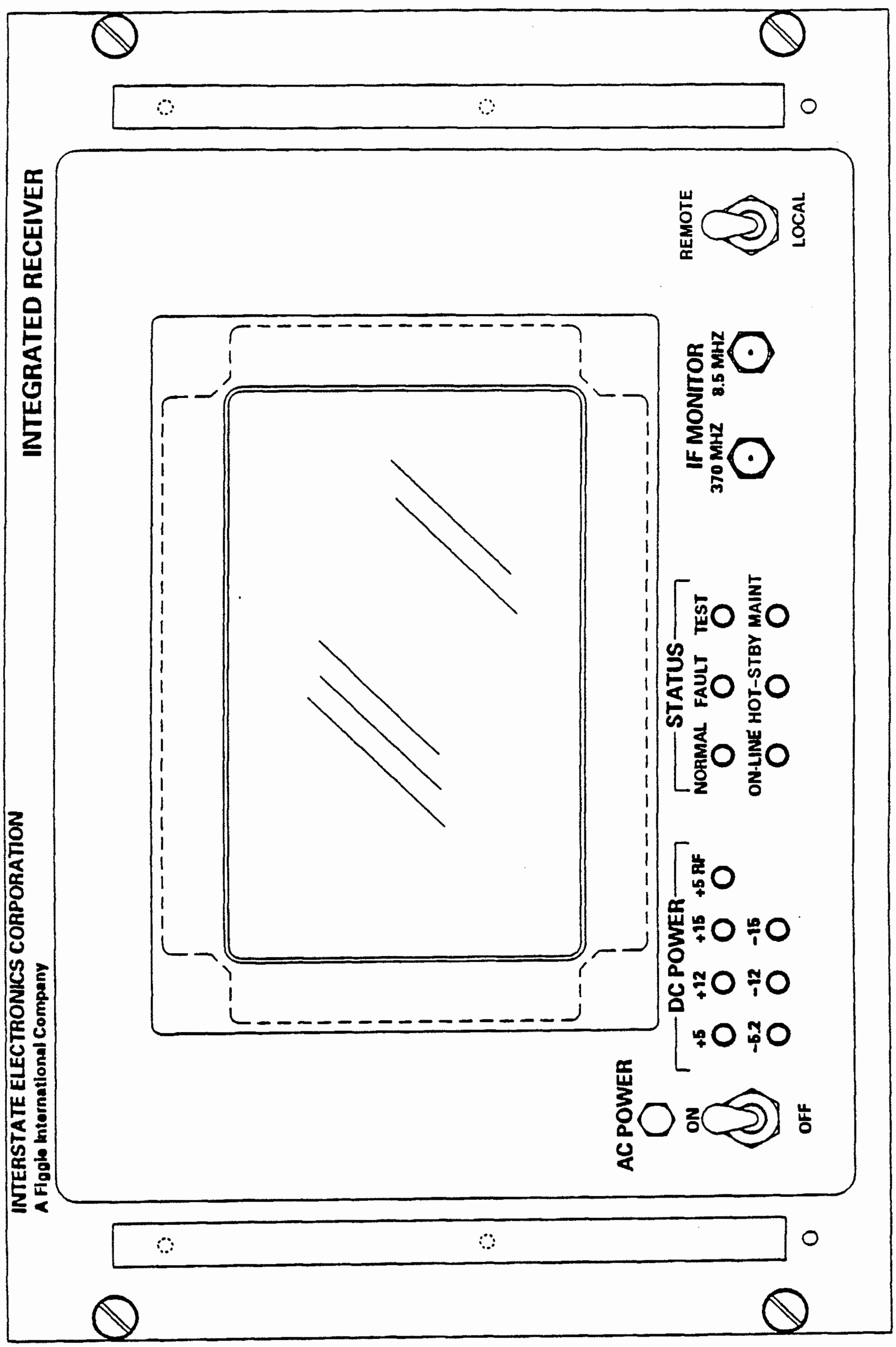

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Figure 8. Integrated Receiver Front Panel

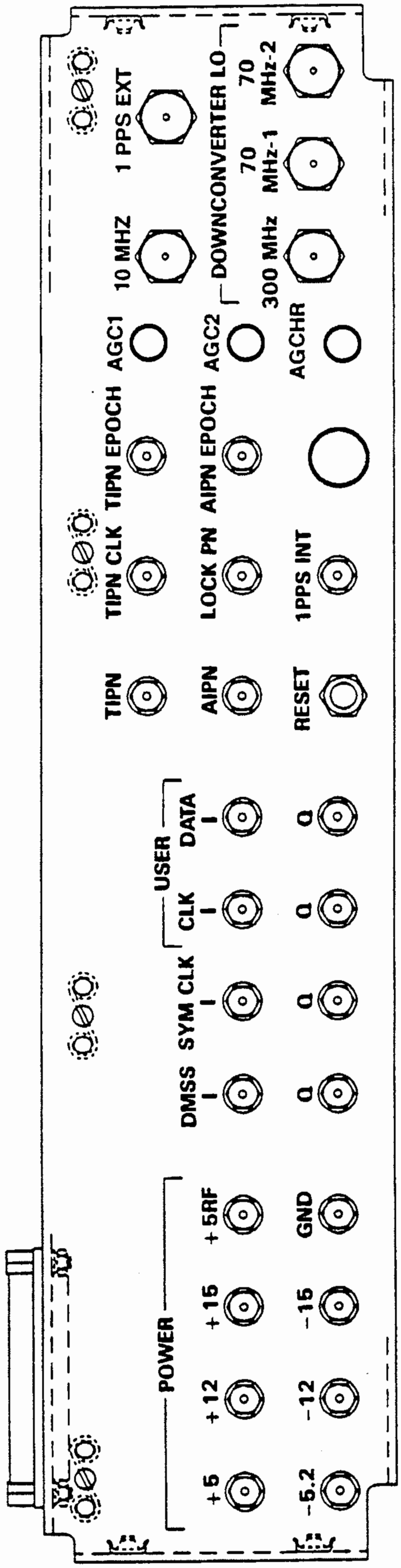

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Figure 9. Integrated Receiver Maintenance Panel

INTERSTATE ELECTRONICS CORPORATION A Figgie International Company	SHEET NUMBER	DOCUMENT NUMBER	REV
	F-9	7472106	C

I79684

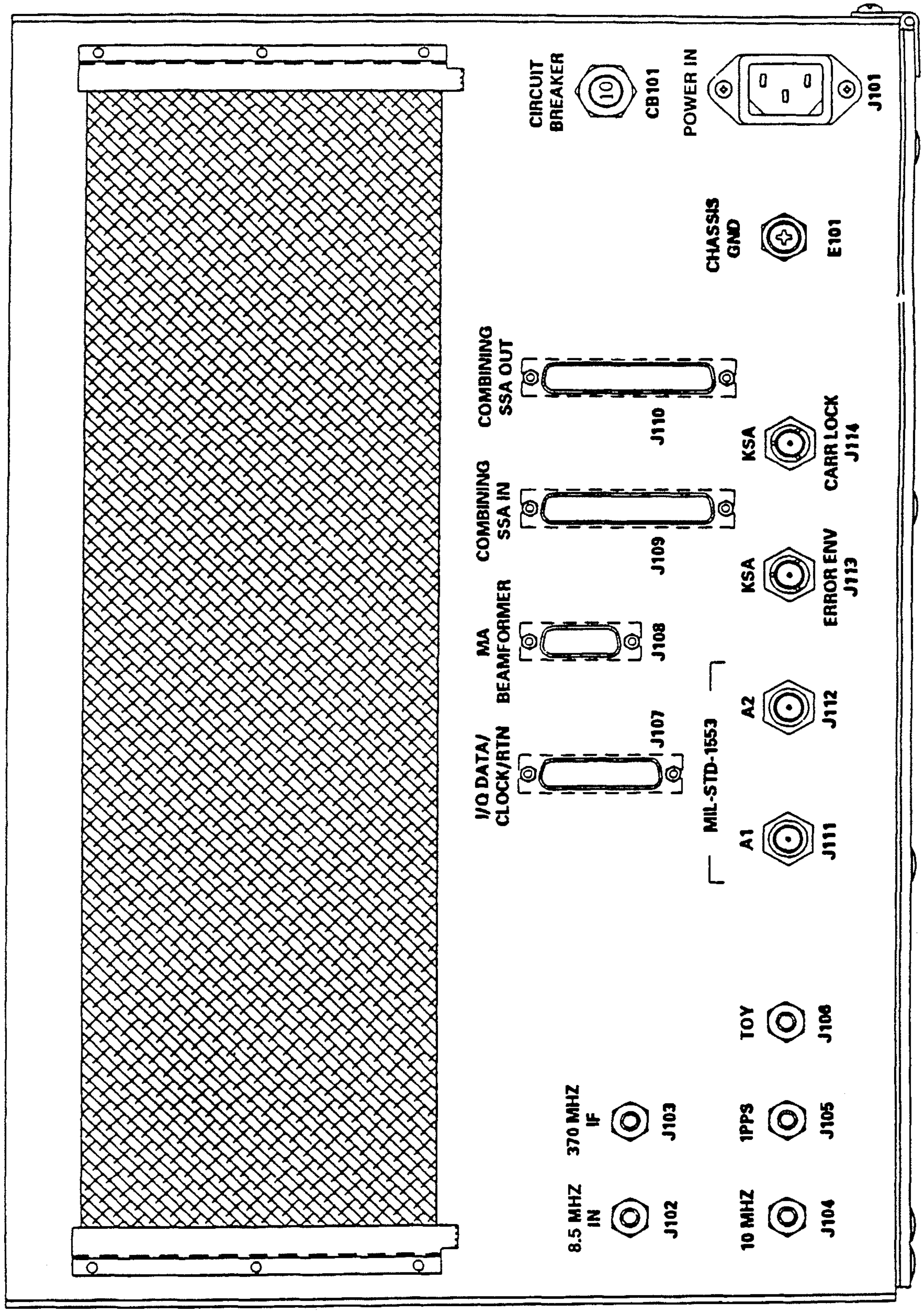
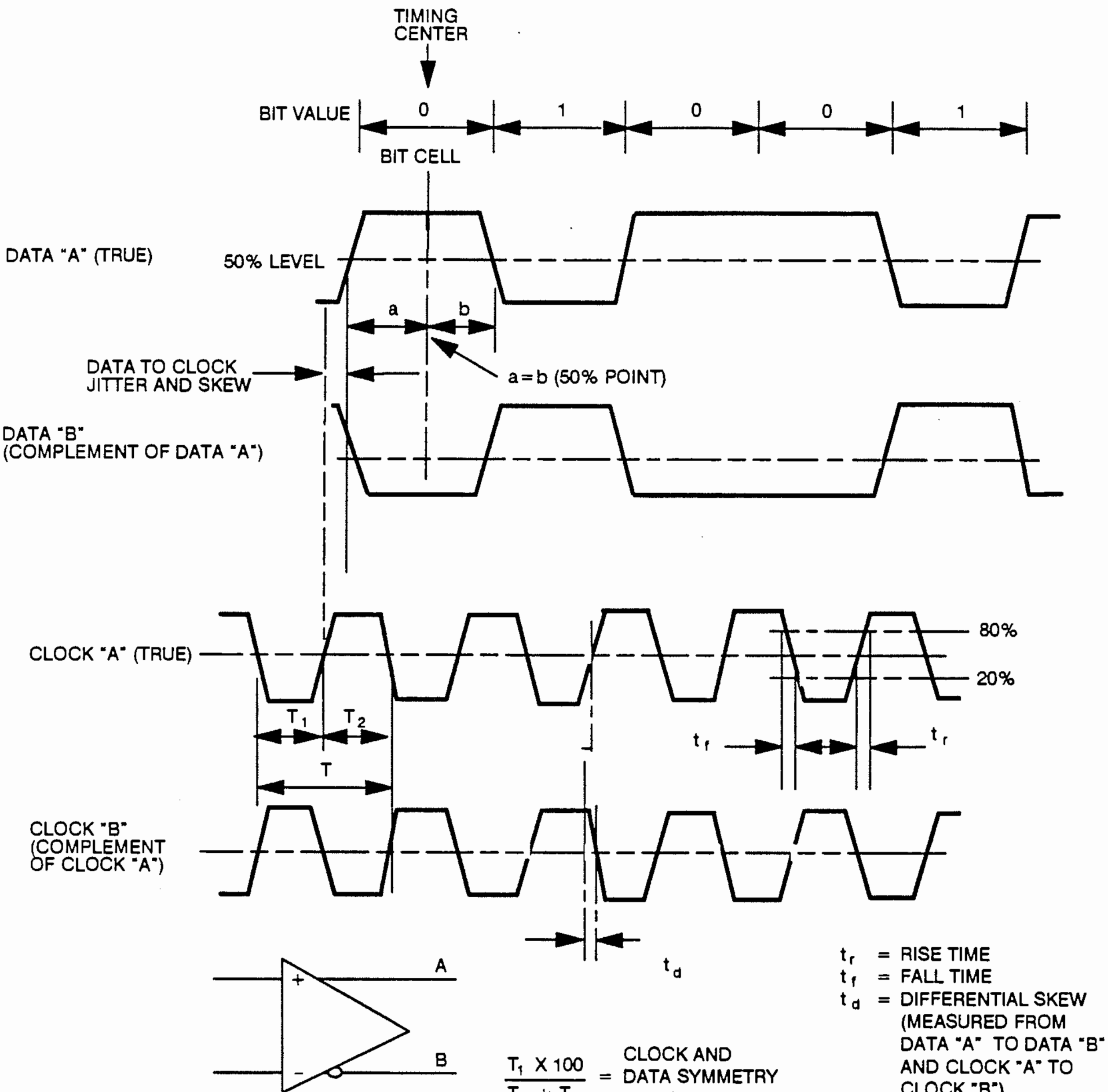


Figure 10. Integrated Receiver Back Panel

	SHEET NUMBER	DOCUMENT NUMBER	REV
INTERSTATE ELECTRONICS CORPORATION A Figgie International Company	F-10	7472106	C

179698

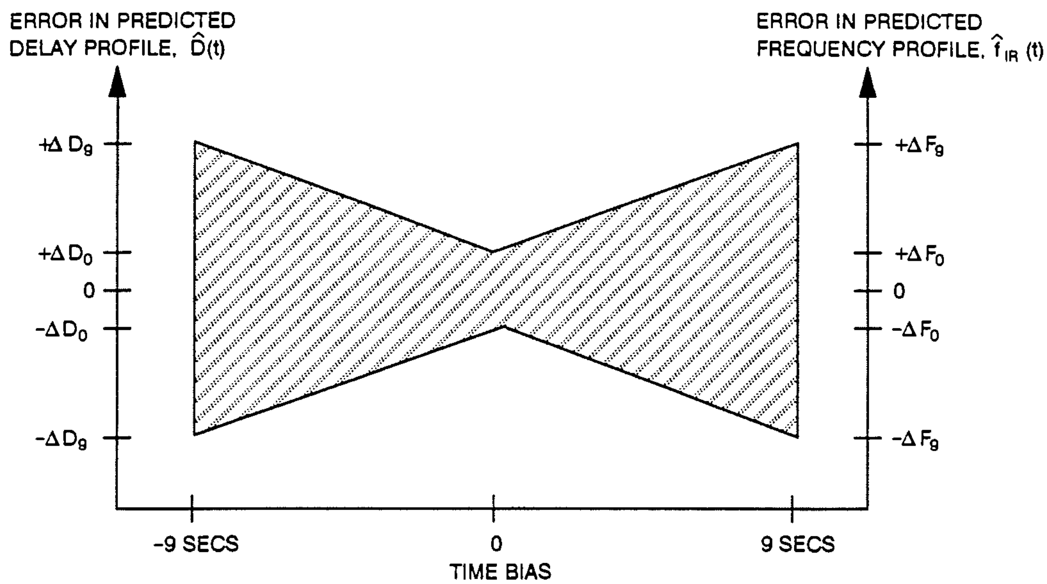


t_r = RISE TIME
t_f = FALL TIME
t_d = DIFFERENTIAL SKEW (MEASURED FROM DATA "A" TO DATA "B" AND CLOCK "A" TO CLOCK "B")

$$\frac{T_1 \times 100}{T_1 + T_2} = \text{CLOCK AND DATA SYMMETRY (PERCENT)}$$

Figure 11. Clock and Data Relationships

179688



	ΔD_0 (μ sec)	ΔD_9 (μ sec)	ΔF_0 (Hz)	ΔF_9 (Hz)	$\Delta \dot{F}_{max}$ (Hz/sec)
<u>For Acquisition</u>					
SSA Coherent	75	720	210	2100	2.76
SSA Non-coherent - Normal	N/A	N/A	810[1]	1800[1]	1.38
SSA Non-coherent - Expanded Search	N/A	N/A	3200[2]	4100[2]	1.38
SSHR Coherent	75	720	690	6900	276
SSHR Non-coherent	N/A	N/A	70000	70000	138
SSA RZS[3]	2	2	1	1	0
<u>For Tracking/Reacquisition/Range and Doppler Measurement</u>					
SSA Coherent	93	900	690	6900	276
SSA Non-coherent - Normal	N/A	N/A	1100[1]	4200[1]	138
SSA Non-coherent - Expanded Search	N/A	N/A	3400[2]	6500[2]	138
SSHR Coherent	75	720	690	6900	276
SSHR Non-coherent	N/A	N/A	70000	70000	138
SSA RZS[3]	2	2	1	1	0

NOTES:

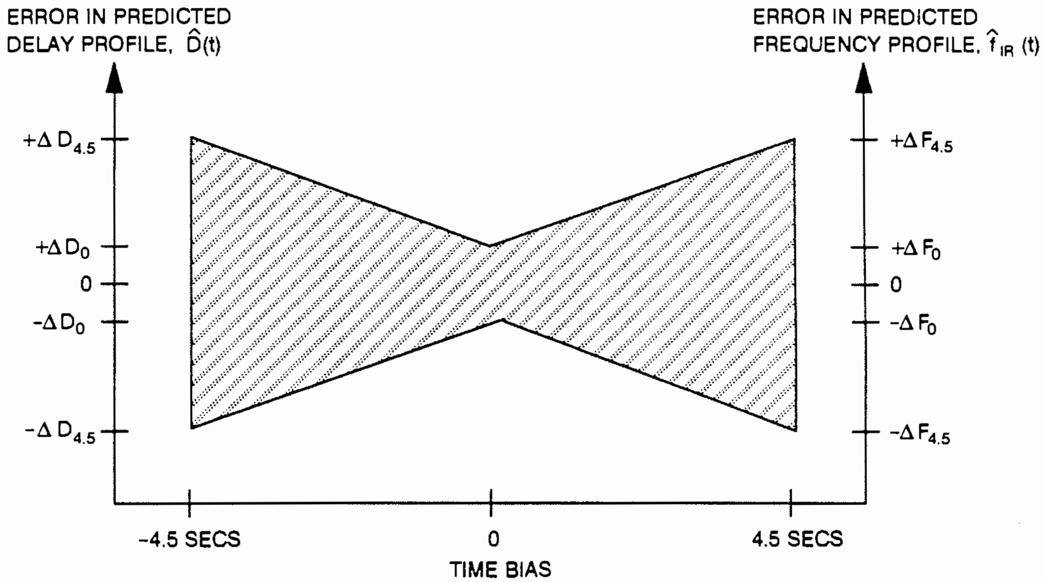
1. For normal SSAR non-coherent services, ΔF_0 and ΔF_9 include a 700 Hz component due to user oscillator uncertainty, which can be regarded as invariant over the duration of a service.

2. When the IR is commanded into Expanded Search mode for an SSAR non-coherent service, ΔF_0 and ΔF_9 include a 3000 Hz component due to user oscillator uncertainty, which can be regarded as invariant over the duration of a service.

3. Errors for range zero set are independent of time bias.

Figure 12. Maximum Error in Predicted Delay and Frequency Profiles as a Function of Time Bias: SSAR and SSHR Services

179689



	ΔD_0 (μ sec)	$\Delta D_{4.5}$ (μ sec)	ΔF_0 (Hz)	$\Delta F_{4.5}$ (Hz)	$\Delta \dot{F}_{max}$ (Hz/sec)
<u>For Acquisition</u>					
KSA Coherent	39	360	680	6800	9.00
KSA Non-coherent - Normal	N/A	N/A	5340[1]	8400[1]	4.50
KSA Non-coherent - Expanded Search	N/A	N/A	20400[2]	23400[2]	4.50
KSHR Mode 1 Non-coherent	N/A	N/A	500000	500000	4.50
KSHR Mode 2 (subcarrier)[3]	N/A	N/A	1000	1000	0.43
KSA RZS[3]	2	2	1	1	0
<u>For Tracking/Reacquisition/Range and Doppler Measurement</u>					
KSA Coherent	39	360	680	6800	9.00
KSA Non-coherent - Normal	N/A	N/A	5340[1]	8400[1]	4.50
KSA Non-coherent - Expand Search	N/A	N/A	20400[2]	23400[2]	4.50
KSHR Mode 1 Non-coherent	N/A	N/A	500000	500000	4.50
KSHR Mode 2 (subcarrier)[3]	N/A	N/A	1000	1000	0.43
KSA RZS[3]	2	2	1	1	0

NOTES:

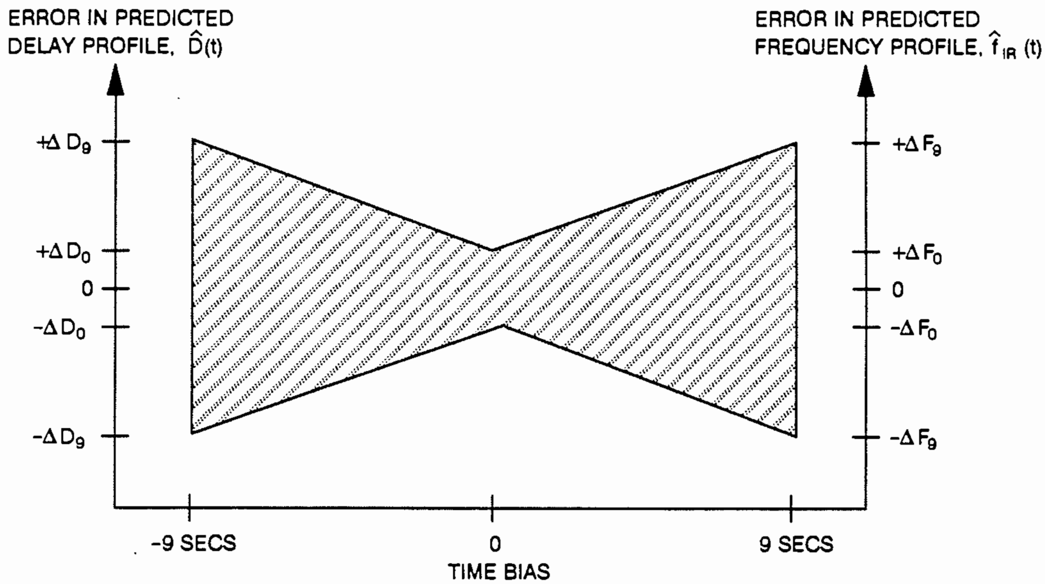
1. For normal KSAR non-coherent services, ΔF_0 and $\Delta F_{4.5}$ include a 5000 Hz component due to user oscillator uncertainty, which can be regarded as invariant over the duration of a service.

2. When the IR is commanded into Expanded Search mode for an KSAR non-coherent service, ΔF_0 and $\Delta F_{4.5}$ include a 20000 Hz component due to user oscillator uncertainty, which can be regarded as invariant over the duration of a service.

3. Errors for range zero set and KSHR subcarrier are independent of time bias.

Figure 13. Maximum Error in Predicted Delay and Frequency Profiles as a Function of Time Bias: KSAR and KSHR Services

179690



	ΔD_0 (μ sec)	ΔD_9 (μ sec)	ΔF_0 (Hz)	ΔF_9 (Hz)	$\Delta \dot{F}_{max}$ (Hz/sec)
<u>For Acquisition</u>					
MA Coherent	75	720	210	2100	2.76
MA Non-coherent - Normal	N/A	N/A	810[1]	1800[1]	1.38
MA Non-coherent - Expanded Search	N/A	N/A	3200[2]	4100[2]	1.38
Calibration[3]	3	3	0.2	0.2	0.1
MA RZS[3]	2	2	2	2	0.1
<u>For Tracking/Reacquisition/Range and Doppler Measurement</u>					
MA Coherent	75	720	210	2100	2.76
MA Non-coherent - Normal	N/A	N/A	810[1]	1800[1]	1.38
Calibration[3]	3	3	0.2	0.2	0.1
MA Non-coherent - Expanded Search	N/A	N/A	3200[2]	4100[2]	1.38
MA RZS[3]	2	2	2.0	2.0	0.1

NOTES:

1. For normal MAR non-coherent services, ΔF_0 and ΔF_9 include a 700 Hz component due to user oscillator uncertainty, which can be regarded as invariant over the duration of a service.

2. When the IR is commanded into Expanded Search mode for an MAR non-coherent service, ΔF_0 and ΔF_9 include a 3000 Hz component due to user oscillator uncertainty, which can be regarded as invariant over the duration of a service.

3. Errors for range zero set and MA calibration are independent of time bias.

Figure 14. Maximum Error in Predicted Delay and Frequency Profiles as a Function of Time Bias: MAR Services

TABLE I. BACK PANEL CONNECTORS AND SIGNALS

Signal Identification and Connector Termination of Back Panel Signals for the Integrated Receiver			
Signal Name	Unit Connector Terminal Number and Type		
Primary AC Power 115VAC Return (white) Safety Ground (green) 115VAC Line (black)	J101 J101-A J101-B J101-C	Input	AC Connector
8.5 MHz IN	J102	Input	SMA Female
370 MHz IF	J103	Input	SMA Female
CTFS 10 MHz	J104	Input	SMA Female
CTFS 1 PPS	J105	Input	SMA Female
CTFS TOY	J106	Input	SMA Female
I/Q DATA/CLOCK/ Remote Terminal Address I Data/Single User Data I Data/Single User Data Return Shield Ground I Data/Single User Clock I Data/Single User Clock Return Shield Ground Q Data Q Data Return Shield Ground	J107 J107-01 J107-02 J107-14 J107-03 J107-04 J107-16 J107-05 J107-06 J107-18	Input/Output	25 pin female D type

Table I. Back Panel Connectors and Signals (Continued)

Signal Identification and Connector Termination of Back Panel Signals for the Integrated Receiver			
Signal Name	Unit Connector Terminal Number and Type		
Q Clock	J107-07		
Q Clock Return	J107-08		
Shield Ground	J107-20		
Remote Terminal Address 0	J107-10		
Remote Terminal Address 1	J107-23		
Remote Terminal Address 2	J107-11		
Remote Terminal Address 3	J107-24		
Remote Terminal Address 4	J107-12		
Remote Terminal Parity	J107-25		
Remote Terminal Return	J107-13		
MA Beamformer	J108	Output	15 pin female D type
I PN	J108-01		
I PN Return	J108-02		
Shield Ground	J108-09		
Q PN	J108-10		
Q PN Return	J108-11		
Shield Ground	J108-03		
I PN Clock	J108-04		
I PN Clock Return	J108-05		
Shield Ground	J108-12		
Q PN Clock	J108-13		
Q PN Clock Return	J108-14		
Shield Ground	J108-06		
Code Status	J108-07		
Code Status Return	J108-08		
Shield Ground	J108-15		

Table I. Back Panel Connectors and Signals (Continued)

Signal Identification and Connector Termination of Back Panel Signals for the Integrated Receiver			
Signal Name	Unit Connector Terminal Number and Type		
SSA Combining In	J109	Input	37 pin male D type
I Combining In Data 0	J109-19		
I Combining In Data 0 Return	J109-20		
Shield Ground	J109-01		
I Combining In Data 1	J109-02		
I Combining In Data 1 Return	J109-03		
Shield Ground	J109-21		
I Combining In Data 2	J109-22		
I Combining In Data 2 Return	J109-23		
Shield Ground	J109-04		
I Combining In Data 3	J109-05		
I Combining In Data 3 Return	J109-06		
Shield Ground	J109-24		
I Combining In Data 4	J109-25		
I Combining In Data 4 Return	J109-26		
Shield Ground	J109-07		
I Combining In Clock	J109-08		
I Combining In Clock Return	J109-09		
Shield Ground	J109-27		
Q Combining In Data 0	J108-28		
Q Combining In Data 0 Return	J108-29		
Shield Return	J109-10		
Q Combining In Data 1	J109-11		
Q Combining In Data 1 Return	J109-12		
Shield Ground	J109-30		
Q Combining In Data 2	J109-31		
Q Combining In Data 2 Return	J109-32		
Shield Ground	J109-13		
Q Combining In Data 3	J109-14		
Q Combining In Data 3 Return	J109-15		
Shield Ground	J109-33		
Q Combining In Data 4	J109-34		
Q Combining In Data 4 Return	J109-35		
Shield Ground	J109-16		
Q Combining In Clock	J109-17		
Q Combining In Clock Return	J109-18		
Shield Ground	J109-36		

Table I. Back Panel Connectors and Signals (Continued)

Signal Identification and Connector Termination of Back Panel Signals for the Integrated Receiver			
Signal Name	Unit Connector Terminal Number and Type		
SSA Combining Out	J110	Output	37 pin for female D type
I Combining Out Data 0	J110-19		
I Combining Out Data 0 Return	J110-20		
Shield Ground	J110-01		
I Combining Out Data 1	J110-02		
I Combining Out Data 1 Return	J110-03		
Shield Ground	J110-21		
I Combining Out Data 2	J110-22		
I Combining Out Data 2 Return	J110-23		
Shield Ground	J110-04		
I Combining Out Data 3	J110-05		
I Combining Out Data 3 Return	J110-06		
Shield Ground	J110-24		
I Combining Out Data 4	J110-25		
I Combining Out Data 4 Return	J110-26		
Shield Ground	J110-07		
I Combining Out Clock	J110-08		
I Combining Out Clock Return	J110-09		
Shield Ground	J110-27		
Q Combining Out Data 0	J110-28		
Q Combining Out Data 0 Return	J110-29		
Shield Ground	J110-10		
Q Combining Out Data 1	J110-11		
Q Combining Out Data 1 Return	J110-12		
Shield Ground	J110-30		
Q Combining Out Data 2	J110-31		
Q Combining Out Data 2 Return	J110-32		
Shield Ground	J110-13		
Q Combining Out Data 3	J110-14		
Q Combining Out Data 3 Return	J110-15		
Shield Ground	J110-33		
Q Combining Out Data 4	J110-34		
Q Combining Out Data 4 Return	J110-35		
Shield Ground	J110-16		
Q Combining Out Clock	J110-17		
Q Combining Out Clock Return	J110-18		
Shield Ground	J110-36		

Table I. Back Panel Connectors and Signals (Continued)

Signal Identification and Connector Termination of Back Panel Signals for the Integrated Receiver			
Signal Name	Unit Connector Terminal Number and Type		
MIL-STD-1553B Bus 1	J111	Input/Output	Twinax, threaded
Bus 1 HI (blue)	Center		
Bus 1 LO (white)	Inner		
Shield (shield)	Shield		
MIL-STD-1553B Bus 2	J112	Input/Output	Twinax, threaded
Bus 1 HI (blue)	Center		
BUS 1 LO (white)	Inner		
Shield (shield)	Shield		
KSA Error Envelope	J113	Output	Twinax, 3-lug
KSA Error Envelope (blue)	Center		
KSA Error Envelope Return (white)	Inner		
Shield (shield)	Shield		
KSA Carrier Lock	J114	Output	Twinax, 3-lug
KSA Carrier Lock (blue)	Center		
KSA Carrier Lock Return (white)	Inner		
Shield (shield)	Shield		

TABLE II. FRONT PANEL CONNECTORS AND SIGNALS

Signal Name	Unit Connector Terminal Type	
370 MHz IF	Output	Female BNC
8.5 MHz IF	Output	Female BNC

TABLE III. MAINTENANCE PANEL TEST POINTS

Signal Name	Unit Connector Terminal Type	
+5 Power	Output	Phone Tip Jack
-5.2 Power	Output	Phone Tip Jack
+12 Power	Output	Phone Tip Jack
-12 Power	Output	Phone Tip Jack
+15 Power	Output	Phone Tip Jack
-15 Power	Output	Phone Tip Jack
+5 RF	Output	Phone Tip Jack
GND	Output	Phone Tip Jack
DMSS I	Output	Phone Tip Jack
DMSS Q	Output	Phone Tip Jack
SYM CLK I	Output	Phone Tip Jack
SYM CLK Q	Output	Phone Tip Jack
USER CLK I	Output	Phone Tip Jack
USER CLK Q	Output	Phone Tip Jack
USER DATA I	Output	Phone Tip Jack
USER DATA Q	Output	Phone Tip Jack
TIPN	Output	Phone Tip Jack
AIPN	Output	Phone Tip Jack
TIPN CLK	Output	Phone Tip Jack
TIPN EPOCH	Output	Phone Tip Jack
AIPN EPOCH	Output	Phone Tip Jack
1 PPS INT	Output	Phone Tip Jack
10 MHz	Output	Female BNC
1 PPS EXT	Output	Female BNC
300 MHz Downconverter LO	Output	Female BNC
70 MHz-1 Downconverter LO	Output	Female BNC
70 MHz-2 Downconverter LO	Output	Female BNC

TABLE IV. IDENTIFICATION OF CONNECTOR TYPES

Connector Type	IEC Part No.	Vendor Part No.
AC Connector	338-020-090	LE10BC Filter Concepts
SMA Connector	374-215-001	2084-0000-00 Omni
Twinax (Threaded)	374-150-024	BJ379-47 Trompeter
37 Pin Male Type D	373-043-985	17-22370-1 (439) Wire-Pro Inc.
BNC	374-019-017	3284-2240-00 Omni
Test Point	M39024/10-01	M39024/10-01
Twinax (Three Lug)	374-150-023	BJ79-47
15 Pin Female Type D	373-049-004	M24308/2-9
25 Pin Female Type D	373-049-003	M24308/2-8
37 Pin Female Type D	373-049-002	M24308/2-7

TABLE V. SIGNAL CHARACTERISTICS AND UNIT INTERFACE REQUIREMENTS FOR PRIMARY AC POWER

Item	Description
Signal Characteristics	
1. Voltage	120 VAC +/- 10%, single phase
2. Frequency	57 Hz to 63 Hz; 60 Hz nominal
3. Power	700 Watts, maximum
Unit Interface Requirements	

1. AC power connector shall have only three pins, designated A, B, and C. Within the unit, color coded conductors shall be connected between pins and the first terminals as follows:

Pin	Conductor Function	Conductor Color*
A	VAC Return	White
B	Safety Ground	Green
C	VAC Line	Black

* AC power cables may be commercial power cords and connectors which meet equivalent standards for safety and function.

TABLE VI. SIGNAL CHARACTERISTICS AND UNIT INTERFACE REQUIREMENTS FOR MIL-STD-1553B DATA BUS

Item	Description
Signal Characteristics	
Signal Characteristics are as per MIL-STD-1553B.	
Unit Interface Requirements	
1. Coupling	Transformer coupled
2. Remote Terminal Address	The unit Remote Terminal Address shall be accommodated via the connector J107 as shown in table I. The IR shall provide internal pull ups for the input signals.
3. Parity	Odd

TABLE VII. SETUP AND EXECUTION TIMES

		IR	
Command	Sync/ Async	Setup Time (in seconds)	Execution Time (in seconds)
Set State	A	N/A	1
Common Config	A	N/A	1
Specific Config IR	A	N/A	1
Start Acquisition	A	N/A	1
Zero Doppler Count	S	1	0
Expand Freq. Search	A	N/A	1
Burn Alert	A	N/A	var
Start Forward Model	S	1	0
Forward Freq Sweep	S	1	120
Forward Doppler Compensation Control	S	1	var
Cold Start	S	1	0
Forward Break Lock	S	1	var
Download - (Note 1)			
Ephemeris Data - (Note 1)			

Note: See STGT-HE-06-02 for Download and Ephemeris Data timing.

TABLE VIII. IR COMMAND STATE TABLE

State / Command	Sync/ Async	Confidence Test	Extended Bit	Standby	Conf. In Prog	Con-figured	Acquisi-tion	Track	Reacq
Set State Command	A								
- Reset			X	X	X	X	X	X	X
- Clear Ephem				X	X	X	X	X	X
- Clear Config				X	X	X	X	X	X
- Clear Both				X	X	X	X	X	X
- Start Extended BIT				X	X	X	X	X	X
- Stop Extended BIT			X						
Download (F/W)	N/A			X					
Download (Ephemeris)	N/A			X	X	X	X	X	X
Common Config Cmd	A			X		X	X	X	X
Specific Config Cmd	A			X		X	X	X	X
Start Acq	A				X	X	X	X	X
Expand Freq Search	A				X	X	X		
Burn Alert	A							X	
Zero Doppler Count	S_1							X	
FWD Freq. Sweep	S_1				X	X	X	X	X
FWD Doppler Control	S_1				X	X	X	X	X
FWD Break Lock	S_1				X	X	X	X	X
Cold Start	S_1				X	X			
Start FWD Model	S_1				X	X			

NOTE:

1. Synchronous command rejection due to state incompataibility is checked immediately prior to execution of the command, not at receipt of the command.

TABLE IX. SPECIFIC CONFIGURATION DATA REQUIREMENTS

Command Data Parameters	KSAR	KSHR	SSAR	SSHR	MAR	MA CAL	Range Zero Set
Service Type	X	X	X	X	X	X	X
Service Mode	X		X	X			
Setup Misc Parameters	X		X	X(1)	X		
I:Q Power Ratio	X(2)		X(2)		X(2)		
Data format (I and Q)	X	X	X	X	X		
Encoding (I and Q)	X		X		X		
Symbol format (I and Q)	X	X	X	X	X		
Operational Light							
Data Rate (I and Q)	X	X	X		X		
Single/Dual channel Mod.	X		X		X		
Return Link Mode 1 and 3 Taps	X(3)		X(3)		X(3)		X
Initial A Register Value	X(4)		X(4)		X(4)	X	
Initial C Register Value	X(4)		X(4)		X(4)	X	
SSA Combining Delay			X	X	(only when combining)		
Jitter (I and Q)	X	X	X	X	X		
Return IF Offset Frequency	X	X	X	X	X		
KSAR I and Q Data Recovery	X						
STGT Return Translation Freq	X	X	X	X	X		
TDRS Return Translation Freq	X	X	X	X	X		
Service Max Data Rate (I and Q)	X		X		X		

NOTES:

1. Only the SSA combining on/off parameter of Setup Misc Parameters is applicable for SSHR.
2. For Dual Data channel configurations only
3. DG-1, Modes 1 and 3 only
4. DG-1, Mode 2 only

TABLE X. COMMON TIME AND FREQUENCY SYSTEM (CTFS) 10 MHZ INPUT

Item		Description
Signal Characteristics		
1.	Nominal frequency	10 MHz
2.	Signal type	Single ended, sinusoidal
3.	Nominal source impedance	50 ohms
4.	Signal level	+ 11 dBm +/- 2 dB into 50 ohms
5.	Single-sideband (SSB) phase noise in 1 Hz bandwidth	
	Frequency Offset From Carrier (Hz)	Phase Noise (dB/Hz)
	0.1	-80
	1	-105
	10	-120
	100	-125
	1,000	-140
6.	Frequency accuracy ($\Delta f/f$)	$+/- 4 \times 10^{-12}$
7.	Frequency stability (square root of zero-dead-time two-sample Allan variance)	
	Averaging Time (Seconds)	Stability
	1	< +/- 5.0 x 10-12
	10	< +/- 2.7 x 10-12
	100	< +/- 8.5 x 10-13
8.	Harmonic distortion	less than -50 dBc
9.	Non-harmonically related spurious	less than -80 dBc
Unit Interface Requirements		
1.	Nominal input impedance	50 ohms
2.	Input VSWR	1.3:1 over (10 +/- 0.5) MHz, maximum

TABLE XI. COMMON TIME AND FREQUENCY SYSTEM (CTFS) 1 PULSE PER SECOND (1 PPS) INPUT

Item		Description
Signal Characteristics		
1.	Nominal frequency	1 Hz
2.	Signal type	Single ended, rectangular pulse
3.	Nominal source impedance	50 ohms
4.	Signal levels	TTL levels
5.	Pulse width	100 microseconds, +/- 0.1 %
6.	Rise and fall times	10 nanoseconds, maximum
7.	Pulse to pulse jitter	2 nanoseconds, maximum
8.	Accuracy	< +/- 25 nanoseconds, referenced to the CTFS master epoch
9.	Sense of signal	Time epoch corresponds to the leading edge of the pulse
Unit Interface Requirements		
1.	Nominal input impedance	50 ohms
2.	VSWR	1.3:1

TABLE XII. COMMON TIME AND FREQUENCY SYSTEM (CTFS) TIME OF YEAR (TOY) INPUT

Item		Description
Signal Characteristics		
1.	Nominal frequency	Per IRIG-B Standard, IRIG-STD 104-70
2.	Signal format	IRIG-B level shift
3.	Nominal source impedance	50 ohms
4.	Signal levels	TTL into 50 ohms
5.	Signal type	Single-ended
Unit Interface Requirements		
1.	Nominal input impedance	50 ohms

TABLE XIII. 370 MHZ IF INPUT

Item	Description
Signal Characteristics	
1. Nominal input frequency	370 MHz
2. Reference bandwidth	As per 3.2.1.1.2.1.1 Signal Plus Noise Power.
3. Nominal source impedance	50 ohms
4. Signal plus noise power	As per 3.2.1.1.2.1.1
5. Spurious input signals	As per 3.2.1.1.2.1.1
Unit Interface Requirements	
1. Nominal input impedance (i.e., input impedance of the Integrated Receiver)	50 ohms
2. Input VSWR	Better than 1.3:1 over a 12 MHz bandwidth centered about 370 MHz
3. Connector	As per table I
4. Connector location	Back panel

TABLE XIV. 8.5 MHZ IF INPUT

Item	Description
Signal Characteristics	
1. Nominal input frequency	8.5 MHz
2. Reference bandwidth	As per 3.2.1.1.2.1.1 Signal Plus Noise Power.
3. Nominal source impedance	50 ohms
4. Signal plus noise power	As per 3.2.1.1.2.1.1
5. Spurious input signals	As per 3.2.1.1.2.1.1
Unit Interface Requirements	
1. Nominal input impedance (i.e., input impedance of the Integrated Receiver)	50 ohms
2. Input VSWR	Better than 1.3:1 over a 6 MHz bandwidth centered about 8.5 MHz
3. Connector	As per table I
4. Connector location	Back panel

TABLE XV. RETURN USS DATA AND CLOCK OUTPUTS

Item	Description
Signal Characteristics	
1. Data format	NRZ
2. Data rate	100 bps to 6 Mbps on I and Q, 100 bps to 12 Mbps on I for a Single Channel User
3. Clock rate (Note 1)	Same as data rate and synchronous with data
4. Signal levels (Note 2)	Similar to RS-422A, except signal frequency extends to 12 MHz
5. Data type (Note 3)	Complementary balanced differential TTL
Unit Interface Requirements	
1. Output impedance	less than 10 ohms
2. Connector type	As per table I
3. Connector location	Back panel

NOTES:

1. Data and clock are synchronous unless data is lost in a channel, in which case the data is clamped to a logical-1 and the clock is output at the nominal data rate.

2. To satisfy these requirements, the chips used for line drivers and line receivers are SN75ALS191 (Texas Instruments) line drivers and DS26C32ACJ (National Semiconductor) line recievers.

   Equivalent or better chips may be used, provided they satisfy RS-422A type requirements up to 12 Mbps.

3. Clock and data relationships are illustrated in figure 11 for Description of the Signals see table XXIX.

TABLE XVI. RECOVERED PN CODE OUTPUTS

Item	Description
Signal Characteristics	
Signal Name	I and Q PN Codes
1. PN chip rate	3.08 Mcps, nominal
2. Signal levels (Note 1)	RS-422A
3. Signal types	Complementary balanced differential TTL
4. Absolute Delay	1265 nsec
5. Delay Variation (Note 2)	Less than 30 nsec over 24 hours
Signal Name	PN Code Lock Status
1. Logic sense	Logic-0 shall indicate PN code loop is locked; logic-1 shall indicate PN code loop is not locked
2. Signal level	RS-422A
3. Signal type	Complementary balanced differential TTL
Unit Interface Requirements	
1. Output impedance	less than 10 ohms
2. Connector type	As per table I
3. Connector location	Back panel

NOTE:

1. Clock and data relationships are illustrated in figure 11.
2. Delta between minimum and maximum delays, over allowable input frequency and power level, and between units.

TABLE XVII. AUTOTRACK OUTPUTS

Item	Description
Signal Characteristics	
Signal Name	Autotrack Error Signal
1. Signal type	Analog
2. Signal levels	12 volts differential, maximum
3. Impedance matching	Differential twisted pair with nominal 249 ohm terminations to ground at the receiver
Signal Name	Carrier Lock
1. Logic sense	Logic-1 shall indicate carrier loop is locked; logic-0 shall indicate carrier loop is not locked
2. Signal level	RS-422A
3. Signal type	Complementary balanced differential TTL
Unit Interface Requirements	
1. Output impedance	less than 10 ohms
2. Connector type	As per table I
3. Connector location	Back panel

TABLE XVIII. SSA COMBINING INPUTS/OUTPUTS

Item	Description
Signal Characteristics	
1. Data rate	100 bps to 3 Mbps on I and Q
2. Clock rate	Same as data rate and synchronous with data
3. Signal levels (Note 1)	RS-422A
4. Data type	Complementary balanced differential TTL
Unit Interface Requirements	
1. Input impedance	100 ohms +/- 2% line-to-line for the combining inputs
2. Output impedance	less than 10 ohms for the combining outputs
3. Connector type	As per table I
4. Connector location	Back panel
NOTE:	
1. Clock and data relationships are illustrated in figure 11, for Description of signals see table XXIX.	

TABLE XIX. SSAR ALLOWABLE IMPLEMENTATION LOSS FOR RATE 1/2 CODING

Data Channel Bit Rate, Rb (kbps)	Allowable Implementation Loss, $L(P_E,Rb)$, at Each Theoretical Eb/No Reference Point for SSAR Rate 1/2 Convolutional Coding (Losses are in units of dB)					
	$P_E = 10^{-5}$ @ 4.2 dB		$P_E = 10^{-6}$ @ 4.8 dB		$P_E = 10^{-7}$ @ 5.4 dB	
	DG1[3]	DG2[4]	DG1[3]	DG2[4]	DG1[3]	DG2[4]
.1 ≤ Rb < 1	2.8	N/A	3.0	N/A	3.5	N/A
1 ≤ Rb < 10	2.8	2.3	3.0	2.5	3.3	2.8
10 ≤ Rb < 100	2.8	2.3	3.0	2.5	3.3	2.8
100 ≤ Rb < 1,000	2.6	2.1	2.8	2.3	3.1	2.6
1,000 ≤ Rb < 3,000	NA	2.1	NA	2.3	NA	2.6
3,000 ≤ Rb ≤ 6,000	NA	2.4	NA	2.6	NA	3.1

NOTES:

1. An additional 0.5 dB of implementation loss is allowed for DG1, Modes 1 and 2, and for the I channel of DG1 Mode 3. This is reflected in the values above.

2. When NRZ-M or NRZ-S data formatting is employed, an additional implementation loss of 0.1 dB is allowed.

3. Column labeled DG1 refers to DG-1 Modes 1 and 2 and I channel of DG-1 Mode 3.

4. Column labeled DG2 refers to DG-2 Modes and Q channel of DG-1 Mode 3.

TABLE XX. SSAR ALLOWABLE IMPLEMENTATION LOSS FOR RATE 1/3 CODING

Data Channel Bit Rate, Rb (kbps)	Allowable Implementation Loss, $L(P_E,Rb)$, at Each Theoretical Eb/No Reference Point for SSAR Rate 1/3 Convolutional Coding (Losses are in units of dB)		
	$P_E = 10^{-5}$ @ 3.9 dB	$P_E = 10^{-6}$ @ 4.5 dB	$P_E = 10^{-7}$ @ 5.1 dB
	DG2	DG2	DG2
1 ≤ Rb < 10	2.5	2.5	2.8
10 ≤ Rb < 100	2.3	2.5	2.8
100 ≤ Rb < 1,000	2.1	2.3	2.6
1,000 ≤ Rb < 2,000	2.1	2.3	2.6
2,000 ≤ Rb < 4,000	2.4	2.6	3.1

1. When NRZ-M or NRZ-S data formatting is employed, an additional implementation loss of 0.1 dB is allowed.

TABLE XXI. SSHR ALLOWABLE IMPLEMENTATION LOSS FOR RATE 1/3 CODING

	$P_E = 10^{-4}$ @ Eb/No = 3.2 dB
Rb = 96 kbps (Mode 1)	1.8 dB
Rb = 192 kbps (Mode 2)	1.8 dB

TABLE XXII. KSAR ALLOWABLE IMPLEMENTATION LOSS FOR RATE 1/2 CODING

Data Channel Bit Rate, Rb (kbps)			Allowable Implementation Loss, $L(P_E,Rb)$, at Each Theoretical Eb/No Reference Point for KSAR Rate 1/2 Convolutional Coding (Losses are in units of dB)						Notes
			$P_E = 10^{-5}$ @ 4.2 dB		$P_E = 10^{-6}$ @ 4.8 dB		$P_E = 10^{-7}$ @ 5.4 dB		
			DG1	DG2	DG1	DG2	DG1	DG2	
.1	$\leq$ Rb <	1	NA	NA	NA	NA	NA	NA	Note 1
1	$\leq$ Rb <	10	3.0	2.5	3.0	2.5	3.3	2.8	
10	$\leq$ Rb <	100	2.8	2.3	3.0	2.5	3.3	2.8	
100	$\leq$ Rb <	1,000	2.6	2.1	2.8	2.3	3.1	2.6	
1,000	$\leq$ Rb <	3,000	NA	2.1	NA	2.3	NA	2.6	
3,000	$\leq$ Rb $\leq$	6,000	NA	2.4	NA	2.6	NA	3.1	

NOTES:

1. KSA data rates do not go below 1 kbps.

Additional Notes

2. An additional 0.5 dB of implementation loss is allowed for DG1, Modes 1 and 2, and for the I channel of DG1 Mode 3. This is reflected in the values above.
3. When NRZ-M or NRZ-S data formatting is employed, an additional implementation loss of 0.1 dB is allowed.
4. Column labeled DG1 refers to DG-1 Modes 1 and 2 and I channel of DG-1 Mode 3.
5. Column labeled DG2 refers to DG-2 Modes and Q channel of DG-1 Mode 3.

TABLE XXIII. KSAR ALLOWABLE IMPLEMENTATION LOSS UNCODED OPERATION

Data Channel Bit Rate, Rb (kbps)	Allowable Implementation Loss, $L(P_E, Rb)$, at Each Theoretical Eb/No Reference Point for KSAR Uncoded Operation (Losses are in units of dB)						
	$P_E = 10^{-5}$ @ 9.6 dB		$P_E = 10^{-6}$ @ 10.6 dB		$P_E = 10^{-7}$ @ 11.5 dB		
	DG1	DG2	DG1	DG2	DG1	DG2	Notes
1 $\leq$ Rb < 10	2.8	2.3	3.0	2.5	3.3	2.8	Note 1
10 $\leq$ Rb < 100	2.6	2.1	2.8	2.3	3.1	2.6	Note 2
100 $\leq$ Rb < 1,000	NA	2.1	NA	2.3	NA	2.6	
1,000 $\leq$ Rb < 6,000	NA	2.1	NA	2.3	NA	2.7	
6,000 $\leq$ Rb $\leq$ 12,000	NA	2.4	NA	2.6	NA	3.1	

NOTES:

1. KSA data rates do not go below 1 kbps.

Additional Notes

2. An additional 0.5 dB of implementation loss is allowed for DG1, Modes 1 and 2, and for the I channel of DG1 Mode 3. This is reflected in the values above.

3. When NRZ-M, NRZ-S, Biphase-M, or Biphase-S data formatting is employed, an additional implementation loss of 0.3dB is allowed.

4. Column labeled DG1 refers to DG-1 Modes 1 and 2 and I channel of DG-1 Mode 3.

5. Column labeled DG2 refers to DG-2 Modes and Q channel of DG-1 Mode 3.

TABLE XXIV. KSHR ALLOWABLE IMPLEMENTATION LOSS FOR CHANNELS 1 AND 2, UNCODED

Data Channel Bit Rate, Rb (kbps)	Allowable Implementation Loss, $L(P_E, Rb)$, at Each Theoretical Eb/No Reference Point for KSHR (Channels 1 and 2) Uncoded Operation (Losses are in units of dB)		
	$P_E = 10^{-5}$ @ 9.6 dB	$P_E = 10^{-6}$ @ 10.6 dB	$P_E = 10^{-7}$ @ 11.5 dB
$16 \leq Rb < 100$	2.3	2.5	2.8
$100 \leq Rb \leq 2{,}000$	2.1	2.3	2.6

NOTE:

1. When NRZ-M, NRZ-S, Biphase-M, or Biphase-S formatting is employed, an additional implementation loss of 0.3 dB is allowed.

TABLE XXV. MAR ALLOWABLE IMPLEMENTATION LOSS FOR RATE 1/2 CODING

Data Channel Bit Rate, Rb (kbps)			Allowable Implementation Loss, $L(P_E, Rb)$, at Each Theoretical Eb/No Reference Point for MAR Rate 1/2 Convolutional Coding. (Losses are in units of dB)						
			$P_E = 10^{-5}$ @ 4.2 dB		$P_E = 10^{-6}$ @ 4.8 dB		$P_E = 10^{-7}$ @ 5.4 dB		
			DG1	DG2	DG1	DG2	DG1	DG2	Notes
.1	≤ Rb <	1	2.8	NA	3.0	NA	3.5	NA	Note 1
1	≤ Rb ≤	50	2.8	NA	3.0	NA	3.3	NA	

NOTES:

1. Multiple Access Return (MAR) services are restricted to Rate 1/2 Data Group 1 signals.

Additional Note

2. When NRZ-M or NRZ-S data formatting is employed, an additional implementation loss of 0.1 dB is allowed.

TABLE XXVI. INPUT PHASE NOISE

	Coherent Turnaround (degrees rms, max.)		Noncoherent (degrees rms, max.)	
	Note 1	Note 2	Note 1	Note 2
SSAR and SSHR				
1 Hz to 10 Hz	2.7	3.1	2.7	3.1
10 Hz to 100 Hz	4.0 10 Hz to 1 kHz	6.7 10 Hz to 1 kHz	2.7	7.6 10 Hz to 1 kHz
100 Hz to 1 kHz	-	-	2.7	-
1 kHz to 6 MHz	2.0	2.3	2.0	2.3
KSAR				
1 Hz to 10 Hz	4.9	5.1	15.4	15.5
10 Hz to 100 Hz	5.4 10 Hz to 1 kHz	6.8 10 Hz to 1 kHz	8.2	8.4
100 Hz to 1 kHz	-	-	2.7	3.9
1 kHz to 150 MHz	2.1	2.4	2.7	2.9
KSHR (Subcarrier)				
1 Hz to 10 Hz	N/A	N/A	15.4	15.7
10 Hz to 100 Hz	N/A	N/A	8.2	8.5
100 Hz to 1 kHz	N/A	N/A	2.7	3.0
1 kHz to 4 MHz	N/A	N/A	2.7	3.0
MAR				
1 Hz to 10 Hz	2.7	2.9	2.7	2.9
10 Hz to 100 Hz	4.0 10 Hz to 1 kHz	4.8 10 Hz to 1 kHz	2.7	6.0 10 Hz to 1 kHz
100 Hz to 1 kHz	-	-	2.7	-
1 kHz to 3 MHz	2.0	2.3	2.0	2.3

Note: 1. Specified performance shall be achieved when input phase noise meets or exceeds these values.
2. Specified performance shall be achieved when input phase noise meets or exceeds these values, provided an additional 0.7 dB of per channel C/No is added to the values specified in 3.2.1.1.2.1 Required Signal Plus Noise Power.

TABLE XXVII. INPUT FREQUENCY DYNAMICS

	SSAR	KSAR	MAR
Nominal Center Frequency	370 MHz	370 MHz	8.5 mhZ
Frequency Dynamics:			
a. Offset From Center			
1. TDRS Tuning	+/-250 kHz	N/A	+/-100 kHz
2. Doppler	+240 kHz -350 kHz	+1972 kHz -1972 kHz	+190 kHz -240 kHz
3. Total	+490 kHz -600 kHz	+1972 kHz -1972 kHz	+290 kHz -340 kHz
b. Maximum Frequency Rate	770 Hz/sec	1500 Hz/sec	240 Hz/sec
c. Maximum Frequency Acceleration			
1. During Service	33 Hz/sec^2	2.0 Hz/sec^2	0.31 Hz/sec^2
2. TDRS Maneuvers[1]	47 Hz/sec^2	17 Hz/sec^2	13 Hz/sec^2

NOTES:

1. For Periods of Duration less than or equal to 50 msec, spaced at least 1 sec apart.

2. The IR shall be designed to operate in the presence of TDRS manuevering dynamics as described above. However, the performance requirements for bit error probability, cycle slippage, and Range and Doppler measurement, do not apply during periods of TDRS maneuvering.

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TABLE XXVIII. ACQUISITION TIMES FOR MINIMUM C/NO

Mode	Minimum C/No, dB-Hz			Time (sec)
	SSA	KSA	MA	
Data Group 1				
Mode 1	36[1]	64[2]	36[1]	1
Mode 2A	36[1]	64[2]	36[1]	1
Mode 2B (Expand Srch)	36[1]	64[2]	36[1]	3
Mode 3	36[1]	64[2]	36[1]	1
Data Group 2				
Mode 1	36[1]	64[2]	N/A	1
Mode 2A	36[1]	64[2]	N/A	1
Mode 2B (Expand Srch)	36[1]	64[2]	N/A	3
S-Band Shuttle				
Mode 1	55.1	N/A	N/A	1
Mode 2	58.1	N/A	N/A	1
Mode 3	38.2	N/A	N/A	1
K-Band Shuttle				
Mode 1 (Main & Sub)	N/A	83.4	N/A	1
Mode 2 (Sub Only)	N/A	81.0	N/A	0.5
Additional Modes				
Range Zero Set	63.0	69.0	55.0	3
MA Calibration	N/A	N/A	25.0	5

Note 1: C/No is defined at the minimum total C/No for which a 10^{-5} P_e is required, as formulated in paragraph 3.2.1.1.2.1.2.b.

Note 2: C/No is defined as 6 dB less than the minimum total C/No required for 10^{-5} P_e.

TABLE XXIX. TIMING PARAMETERS

Parameter	Requirement
Clock Asymmetry	50 ± 5 percent, max.
Differential (A) to (B) Voltage [Clock or Data]	2.0 V, min.
Time Skew (A) to (B) [Data or Clock]	6.5 ns, max.
Time Skew (A) to (A) and (B) to (B) [Data to Clock]	25 percent of a bit period, max.
20 to 80 Percent Differential Transition Time [Data and Clock]	12 ns, max.

Definitions

A. Specified Parameters

See figure F-11, for an illustration of the parameters defined as follows:

1. Clock Asymmetry - This parameter specifies the allowable clock duty cycle range around 50 percent.

2. Diff (A) to (B) Volt - This parameter specifies the allowable plus or minus differential voltage to ensure a voltage at the receiver input capable of producing a full receiver output swing.

3. Time Skew (A) to (B) - This parameter identifies the allowed time skew between the (A) cable and the (B) cable of any differentially transmitted signal. The total time skew varies linearly along the total cable length. The total time skew is the difference between the driver output skew and worst case receiver input skew.

4. Time Skew (A) Data to (A) Clock - This parameter identifies the allowed time skew between a clock signal (A cable) and its related data signal or signals (A cable). This parameter is evaluated on an instantaneous clock period to data period basis. It includes all combination effects of clock asymmetry and jitter conditions in their total affect on clock transition and data midpoint skew.

B. Logical Sense

The logical signal exchange between the driver and receiver shall be in accordance with the following convention for balanced differential interfaces:

1. The (A) terminal of the driver shall be negative with respect to the (B) terminal for binary 1 exchange.

2. The (A) terminal of the driver shall be positive with respect to the (B) terminal for a binary 0 exchange.

3. The significant transition for the clock signal is the negative-going transition of the A-line with respect to the B-line. This transition shall occur within the specified tolerance of the midpoint of data bit period.

4. All data crossings shall be coincident with the positive going clock transitions.

Appendix I

10. SIGNAL PARAMETERS AND CONSTRAINTS

10.1 SCOPE

This appendix provides detailed descriptions of signal parameters and constraints for STGT User Service Subsystem (USS) return data supported by the Integrated Receiver in the S-band Single Access (SSA) Equipment, K-band Single Access (KSA) Low Data Rate Equipment and Multiple Access (MA) Receiver/Transmit Equipment.

10.2 RETURN SIGNAL PARAMETERS AND CONSTRAINTS

This section provides the data format and channel encoding for SSA, KSA and MA return links, including S-band and K-band shuttle.

10.2.1 Return Signal Formats

10.2.1.1 SSA and SSHR Signal Formats

10.2.1.1.1 SSA DG-1 Mode 1

a. Single data channel data rate restrictions

Coded (r=1/2), NRZ	0.1 to 150 kbps
Coded (r=1/2), Biphase	0.1 to 75 kbps

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

Coded (r=1/2), NRZ	0.1 to 150 kbps
Coded (r=1/2), Biphase	0.1 to 75 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

c. Data Format NRZ-L,M,S

(1) Data format is independent for the I and Q channels.

d. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

e. Encoding and Interleaving Code 1

(1) Symbols generated from G1 will precede symbols generated form G2 relative to the data bit period.

(2) No symbol interleaving is required for this mode

f. Data Modulation - SQPN with identical data on the I and Q channels for single data channel modes. PN/BPSK (partial transponder failure) single data channel. SQPN/QPSK or SQPN/UQPSK for dual channels.

g. I/Q Power Imbalance - 1:1 to 1:4

h. PN Coding

Length	(2^10 - 1) x 256 chips
Code Family	Truncated 18-stage shift register per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.
Epoch Reference	
I channel	Synchronous with Forward range channel
Q channel	Delayed (x+1/2) chips relative to I-channel epoch, where x is determined by the user spacecraft ID per STDN 108.

10.2.1.1.2 SSA DG-1 Mode 2

a. Single data channel data rate restrictions

Coded (r=1/2), NRZ 1 to 150 kbps
Coded (r=1/2), Biphase 1 to 75 kbps

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

Coded (r=1/2), NRZ 1 to 150 kbps
Coded (r=1/2), Biphase 1 to 75 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

c. Data Format NRZ-L,M,S

(1) Data format is independent for the I and Q channels.

d. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

e. Encoding and Interleaving Code 1

(1) Symbols generated from G1 will precede symbols generated form G2 relative to the data bit period.

(2) No symbol interleaving is required for this mode

f. Data Modulation - SQPN with identical data on the I and Q channels for single data channel modes. PN/BPSK (partial transponder failure) single data channel. SQPN/QPSK or SQPN/UQPSK for dual data channels.

g. I/Q Power Imbalance - 1:1 to 1:4

h. PN Coding

Length	2^11 - 1 chips
Code Family	Gold codes per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.
Epoch Reference	
I channel	Synchronous with the user spacecraft oscillator
Q channel	Epoch delayed 1/2 chips relative to IPN Epoch

10.2.1.1.3 SSA DG-1 Mode 3

a. Dual data channel (QPSK) I and Q channel data rate restrictions:

I Channel

Coded (r=1/2), NRZ	0.1 to 150 kbps
Coded (r=1/2), Biphase	0.1 to 75 kbps

Q Channel

Coded (r=1/2) NRZ	1 kbps to 3 Mbps
Coded (r=1/2) Biphase	1 kbps to 1.5 Mbps
Coded (r=1/3) NRZ	1 kbps to 2 Mbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

b. Data Format NRZ-L,M,S

(1) Data format is independent for the I and Q channels.

c. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

d. Encoding and Interleaving

(1) Code 1 or code 3 (code 3 only on the Q channel for SSA DG-1 Mode 3); independent for the I and Q channel.

(2) Interleaving may be used for data rates exceeding 150 kbps with rate 1/2 coding and 100 kbps with rate 1/3 coding on the Q channel

e. Data Modulation: QPSK or UQPSK dual data channel, I channel PN spread.

f. I/Q Power Imbalance - Continuously tunable from 1:1 to 1:4

g. PN Coding

Length	(2^10 - 1) x 256 chips
Code Family	Truncated 18-stage shift register per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.
Epoch Reference	
I channel	Synchronous with Forward range channel
Q channel	Delayed (x+1/2) chips relative to I-Channel Epoch where x is determined by the user spacecraft ID per STDN 108.

10.2.1.1.4 SSA DG-2

a. Single data channel data rate restrictions (SQPSK)

(1) Alternate I/Q encoded symbols (G1 on I & G2 on Q)

Coded (r=1/2), NRZ	1 to 300 kbps

(2) Alternate I/Q data bits

Coded (r=1/2), NRZ	1 to 6000 kbps
Coded (r=1/3), NRZ	1 to 4000 kbps

(3) Interleaving may be commanded for data rates above 300 kbps, for rate 1/2 coding, and above 200 kbps for rate 1/3 coding.

(4) I symbols precede Q symbols by one-half symbol.

(5) G2 symbols from the encoded may be normal or inverted, as commanded.

b. Single data channel data rate restrictions (BPSK)

Coded (r=1/2), NRZ	1 to 3000 kbps
Coded (r=1/2), biphase	1 to 1500 kbps
Coded (r=1/3), NRZ	1 to 2000 kbps

(1) Interleaving may be commanded only for symbol rates above 150 kbps, with rate 1/2 coding, NRZ, and above 100 kbps for rate 1/3 coding, NRZ.

(2) For NRZ symbols, G2 symbols from the encoder may be normal or inverted, as commanded.

(3) For biphase symbols, G2 symbols are always normal polarity.

(4) G1 symbols are always inverted for code 2.

c. Dual data channel (QPSK) I and Q channel data rate restrictions:

Coded (r=1/2), NRZ	1 to 3000 kbps
Coded (r=1/2), Biphase	1 to 1500 kbps
Coded (r=1/3), NRZ	1 to 2000 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

(2) Interleaving may be commanded only for data rates above 150 kbps, for rate 1/2 coding, NRZ, and above 100 kbps for rate 1/3 coding, NRZ.

(3) For NRZ, G2 symbols may be normal or inverted, as commanded.

(4) For biphase, G2 symbols are always normal polarity.

d. Data Format NRZ-L,M,S

(1) Data format is independent for the I and Q channels.

e. Symbol Format NRZ-L, Biphase-L

(1) Symbol format is independent for the I and Q channels.

f. Encoding and Interleaving

(1) Code 1: Single data channels (SQPSK or BPSK) and dual data channels

(2) Code 2: Single data channel (BPSK only).

(3) Code 3: Single data channels (SQPSK or BPSK) and dual data channels.

g. Data Modulation

BPSK	Single data channel
SQPSK	Single data channel
QPSK/UQPSK	Dual data channel

h. I/Q Power Imbalance

(1) 1:1 QPSK and SQPSK

(2) 4:1 UQPSK

10.2.1.1.5 SSHR

a. Data rate restrictions

(1) Mode 1

Coded (r=1/3), Biphase	96 kbps

(2) Mode 2

Coded (r=1/3), Biphase 192 kbps

(3) Mode 3: No data, CW only.

b. Data Format NRZ-L

c. Symbol Format Biphase-L

d. Encoding Code 4

(1) Interleaving is never used in this mode.

e. Data Modulation BPSK

10.2.1.1.6 SSA Range Zero Set

a. Single data channel data rate restrictions:

N/A - No data

b. Dual data channel I & Q data rate restrictions:

N/A - No data

c. Data Format

N/A

d. Symbol Format

N/A

e. Encoding and Interleaving

N/A

f. Data Modulation - PN BPSK on I channel with no data or PN Q channel (transponder failure)

g. I/O power unbalance:

$\leq$ 10:1

h. PN Coding.

Length $(2^{10}-1) \times 256$ chips

Code Family Truncated 18 stage shift register per STDN 108

Chip Rate per paragraph 3.2.1.1.3.1.4.

10.2.1.2 KSA and KSHR Return Signals

10.2.1.2.1 KSA DG-1 Mode 1

a. Single data channel data rate restrictions

Uncoded, NRZ	1 to 300 kbps
Uncoded, Biphase	1 to 150 kbps
Coded (r=1/2), NRZ	1 to 150 kbps
Coded (r=1/2), Biphase	1 to 75 kbps

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

Uncoded, NRZ	1 to 300 kbps
Uncoded, Biphase	1 to 150 kbps
Coded (r=1/2), NRZ	1 to 150 kbps
Coded (r=1/2), Biphase	1 to 75 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

c. Data Format NRZ-L,M,S; Biphase-L,M,S

(1) Data format is independent for the I and Q channels.
(2) Biphase formats for uncoded operation only.

d. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

e. Encoding and Interleaving Code 1

(1) Symbols generated from G1 will precede symbols generated form G2 relative to the data bit period.

(2) No symbol interleaving is required for this mode

f. Data Modulation - SQPN with identical data on the I and Q channels for single data channel modes. PN/BPSK (partial transponder failure) single data channel. SQPN/QPSK or SQPN/UQPSK for dual channel modes.

g. I/Q Power Imbalance - 1:1 to 1:4

h. PN Coding

Length	(2^10 - 1) x 256 chips
Code Family	Truncated 18-stage shift register per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.

Epoch Reference

I channel	Synchronous with Forward range channel
Q channel	Delayed (x+1/2) chips relative to I-Channel Epoch where x is determined by the user spacecraft ID per STDN 108

10.2.1.2.2 KSA DG-1 Mode 2

a. Single data channel data rate restrictions

Uncoded, NRZ	1 to 300 kbps
Uncoded, Biphase	1 to 150 kbps
Coded (r=1/2), NRZ	1 to 150 kbps
Coded (r=1/2), Biphase	1 to 75 kbps

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

Uncoded, NRZ	1 to 300 kbps
Uncoded, Biphase	1 to 150 kbps
Coded (r=1/2), NRZ	1 to 150 kbps
Coded (r=1/2), Biphase	1 to 75 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

c. Data Format NRZ-L,M,S; Biphase-L,M,S

(1) Data format is independent for the I and Q channels.
(2) Biphase formats for uncoded operation only.

d. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

e. Encoding and Interleaving Code 1

(1) Symbols generated from G1 will precede symbols generated form G2 relative to the data bit period.

(2) No symbol interleaving is required for this mode.

f. Data Modulation - SQPN with identical data on the I and Q channels for single data channel modes. PN/BPSK (partial transponder failure) single data channel. SQPN/QPSK or SQPN/UQPSK for dual channel modes.

g. I/Q Power Imbalance - 1:1 to 1:4

h. PN Coding

Length	2^11 - 1 chips
Code Family	Gold codes per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.

Epoch Reference

I channel	Synchronous with the user spacecraft oscillator
Q channel	Epoch delayed 1/2 chips relative to IPN Epoch

10.2.1.2.3 KSA DG-1 Mode 3

a. Dual data channel (QPSK) I and Q channel data rate restrictions:

I Channel

Uncoded, NRZ	1 to 300 kbps
Uncoded, Biphase	1 to 150 kbps
Coded (r=1/2), NRZ	1 to 150 kbps
Coded (r=1/2), Biphase	1 to 75 kbps

Q Channel

Uncoded, NRZ	1 kbps to 150 Mbps
Uncoded, Biphase	1 kbps to 5 Mbps
Coded (r=1/2) NRZ	1 kbps to 75 Mbps
Coded (r=1/2) Biphase	1 kbps to 5 Mbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

(2) IR Q channel data recovery is required over the following ranges:

Uncoded NRZ	1 kbps to 6 Mbps
Uncoded Biphase	1 kbps to 3 Mbps
Coded (r=1/2), NRZ	1 kbps to 3 Mbps
Coded (r=1/2), biphase	1 kbps to 1.5 Mbps

b. Data Format NRZ-L,M,S; Biphase-L,M,S

(1) Data format is independent for the I and Q channels.
(2) Biphase for uncoded operation only.

c. Symbol Format NRZ-L, Biphase-L

1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

d. Encoding and Interleaving

1. Code 1

e. Data Modulation: QPSK/UQPSK, I channel PN spread.

f. I/Q Power Imbalance - 1:1 to 1:4

g. PN Coding

Length	(2^10 - 1) x 256 chips
Code Family	Truncated 18-stage shift register per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.

Epoch Reference

I channel	Synchronous with Forward range channel
Q channel	Delayed (x+1/2) chips relative to I-Channel Epoch where x is determined by the user spacecraft ID per STDN 108

10.2.1.2.4 KSA DG-2

a. Single data channel, alternate I/Q data bits, data rate restrictions (Uncoded, SQPSK)

Uncoded, NRZ	1 kbps to 300 Mbps
Coded (r=1/2), NRZ	10 Mbps to 150 Mbps

(1) I and Q channels consist of alternate bits of a single data channel.

(2) I and Q channels will be separately differentially formatted prior to modulation.

(3) I symbols precede Q symbols by one-half symbol.

(4) The IR is required to perform data recovery only for uncoded operation with data rates less than or equal to 12 Mbps.

b. Single data channel, alternate I/Q encoded symbols, data rate restrictions (Coded SQPSK)

Coded (r=1/2), NRZ	1 kbps to 10 Mbps

(1) Symbols precede Q symbols by one-half symbol.

(2) Single data channel contains two concurrent output symbols of the convolutional encoder on the I and Q channels.

(3) The IR is required to perform data recovery only for data rates less than or equal to 6 Mbps.

c. Single data channel data rate restrictions (BPSK)

Uncoded, NRZ	1 kbps to 100 Mbps
Uncoded, biphase	1 kbps to 5 Mbps
Coded (r=1/2), NRZ	1 kbps to 50 Mbps
Coded (r=1/2), biphase	1 kbps to 5 Mbps

(1) The IR is required to perform data recovery only under the following conditions:

Uncoded, NRZ	1 kbps to 6 Mbps
Uncoded, biphase	1 kbps to 3 Mbps
Coded (r=1/2), NRZ	1 kbps to 3 Mbps
Coded (r=1/2), biphase	1 kbps to 1.5 Mbps

d. Dual data channel (QPSK) I and Q channel data rate restrictions:

Uncoded, NRZ	1 kbps to 150 Mbps
Uncoded, Biphase	1 kbps to 5 Mbps
Coded (r=1/2), NRZ	1 kbps to 75 Mbps
Coded (r=1/2), Biphase	1 kbps to 5 Mbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

(2) Either channel may be uncoded or convolutionally encoded.

(3) The IR is required to recover data only under the following conditions:

Uncoded, NRZ	1 kbps to 6 Mbps
Uncoded, biphase	1 kbps to 3 Mbps
Coded (r=1/2), NRZ	1 kbps to 3 Mbps
Coded (r=1/2), biphase	1 kbps to 1.5 Mbps

e. Data Format NRZ-L,M,S; Biphase-L,M,S

(1) Data format is independent for the I and Q channels.
(2) Biphase formats for uncoded operation only.

f. Symbol Format NRZ-L, Biphase-L

(1) For dual data channel configuration, Symbol format is independent for the I and Q channels.

g. Encoding and Interleaving

(1) Code 1: Single data channels (SQPSK or BPSK) and dual data channels

h. Data Modulation

BPSK	Single data channel
SQPSK	Single data channel
QPSK/UQPSK	Dual data channel

i. I/Q Power Imbalance

(1) 1:1 QPSK and SQPSK

(2) 4:1 UQPSK

10.2.1.2.5 <u>KSHR</u>

a. Mode 1, three data channels data rate restrictions

Channel 3:

Coded (r=1/2), NRZ	2 Mbps to 50 Mbps

Channel 2:

Uncoded, NRZ	16 kbps to 2 Mbps
Uncoded, biphase	16 kbps to 2 Mbps

Channel 1:

Uncoded, NRZ	192 kbps
Uncoded, biphase	192 kbps

(1) The IR is required to recover data for channels 1 and 2 only.

(2) Channel 3 may contain no data, in which case the I carrier is transmitted unmodulated.

b. KSHR mode 2, subcarrier only, data rate restrictions:

Channel 2:

Uncoded, NRZ	16 kbps to 2 Mbps
Uncoded, biphase	16 kbps to 2 Mbps

Channel 1:

Uncoded, NRZ	192 kbps
Uncoded, biphase	192 kbps

c. Data Format NRZ-L,M,S; Biphase L,M,S for channels 1 & 2, NRZ-LMS for channel 3

(1) Data format is independent channels 1, 2, & 3

d. I/Q Power Balance : Channel 3 to subcarrier power ratio is 4:1. Channel 2 to channel 1 power ratio is 4:1.

e. Modulation - I carrier is modulated by channel 3, Q carrier is modulated by an 8.5 MHz subcarrier that is UQPSK modulated with the channel 1 and channel 2 data streams.

f. Encoding

(1) Code 1, for channel 3 only.
(2) G2 symbols from the encoder are always inverted.

10.2.1.2.6 KSA Range Zero Set

a. Single data channel data rate restrictions:

N/A - No data

b. Dual data channel I & Q data rate restrictions:

N/A - No data

c. Data Format

N/A

d. Symbol Format

N/A

e. Encoding and Interleaving

N/A

f. Data Modulation - PN BPSK on I channel with no data or PN Q channel (transponder failure)

g. I/Q power unbalance:

$\leq$ 10:1

h. PN Coding.

Length $(2^{10}-1) \times 256$ chips

Code Family Truncated 18 stage shift register per STDN 108

Chip Rate per paragraph 3.2.1.1.3.1.4

10.2.1.3 Multiple Access Return Signals

10.2.1.3.1 MA DG-1 Mode 1

a. Single data channel data rate restrictions

Coded (r=1/2), NRZ	0.1 to 50 kbps
Coded (r=1/2), Biphase	0.1 to 50 kbps

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

Coded (r=1/2), NRZ	0.1 to 50 kbps
Coded (r=1/2), Biphase	0.1 to 50 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.

(2) The sum of the I & Q data rates will not exceed 50 Kbps.

c. Data Format NRZ-L,M,S

(1) Data format is independent for the I and Q channels.

d. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

e. Encoding and Interleaving Code 1

(1) Symbols generated from G1 will precede symbols generated form G2 relative to the data bit period.

(2) No symbol interleaving is required for this mode

f. Data Modulation - SQPN/QPSK with identical data on the I and Q channels for single data channel modes. PN/BPSK (partial transponder failure) single data channel. SQPN/QPSK or SQPN/UQPSK for dual data channels.

g. I/Q Power Imbalance - 1:1 to 1:4

h. PN Coding

Length	(2^10 - 1) x 256 chips
Code Family	Truncated 18-stage shift register per STDN 108
Chip Rate	As defined in 3.2.1.1.3.1.4.

Epoch Reference

I channel	Synchronous with Forward range channel
Q channel	Delayed (x+1/2) chips relative to I-Channel Epoch where x is determined by the user spacecraft ID per STDN 108

10.2.1.3.2 <u>MA DG-1 Mode 2</u>

a. Single data channel data rate restrictions

Coded (r=1/2), NRZ	1 to 50 kbps
Coded (r=1/2), Biphase	1 to 50 kbps

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

Coded (r=1/2), NRZ	1 to 50 kbps
Coded (r=1/2), Biphase	1 to 50 kbps

(1) Data signals on the I and Q channels may be independent and asynchronous.
(2) The sum of the I & Q data rates will not exceed 50 kbps.

c. Data Format NRZ-L,M,S

(1) Data format is independent for the I and Q channels.

d. Symbol Format NRZ-L, Biphase-L

(1) When NRZ channel symbols are used, the G2 symbols may be normal or inverted, as commanded.

(2) G2 symbols are always normal polarity for biphase.

(3) Symbol format is independent for the I and Q channels.

e. Encoding and Interleaving Code 1

(1) Symbols generated from G1 will precede symbols generated form G2 relative to the data bit period.

(2) No symbol interleaving is required for this mode

f. Data Modulation - SQPN/QPSK with identical data on the I and Q channels for single data channel modes. PN/BPSK (partial transponder failure) single data channel SQPN/QPSK or SQPN/UQPSK for dual data channels.

g. I/Q Power Imbalance - 1:1 to 1:4

h. PN Coding

Length 2^11 - 1 chips

Code Family Gold codes per STDN 108

Chip Rate As defined in 3.2.1.1.3.1.4.

Epoch Reference

I channel Synchronous with the user spacecraft oscillator

Q channel Epoch delayed 1/2 chips relative to I PN Epoch.

10.2.1.3.3 MA Range Zero Set

a. Single data channel data rate restrictions:

N/A - No data

b. Dual data channel I & Q data rate restrictions:

N/A - No data

c. Data Format

N/A

d. Symbol Format

N/A

e. Encoding and Interleaving

N/A

f. Data Modulation - PN BPSK on I channel with no data or PN Q channel (transponder failure)

g. I/Q power unbalance:

$\leq$ 10:1

h. PN Coding.

Length $(2^{10}-1) \times 256$ chips

Code Family Truncated 18 stage shift register per STDN 108

Chip Rate per paragraph 3.2.1.1.3.1.4

10.2.1.3.4 Calibration

a. Single data channel data rate restrictions

N/A No data

b. Dual data channel (QPSK) I and Q channel data rate restrictions:

N/A No data

c. Data Format N/A

d. Symbol Format N/A

e. Encoding and Interleaving N/A

f. Data Modulation - SQPN with no data on the I and Q channels.

g. I/Q Power Imbalance 1:1

h. PN Coding

Length	2^n - 1 chips
Code Family	Per STDN 108
Chip Rate	Transmitted rate is 3,078,688.$\bar{0}$ chips/sec where the overbar indicates that the final zero is repeated to the number of decimal places consistent with the accuracy of the CTFS.

Epoch Reference

I channel	Synchronous with CTFS 1 PPS Epoch
Q channel	Delayed 1/2 chip relative to I-Channel Epoch

10.2.2 Coding Characteristics

The unit shall support the following convolutional encoding modes;

a. Code 1

(1) Convolutional, non-systematic, transparent

(2) Rate 1/2, constraint length 7

(3) Generator functions:
G1 = 1111001
G2 = 1011011

(4) Symbols generated from G1 shall precede symbols generated from G2 relative to the data bit period

(5) Symbols from G2 shall either be true or complemented as commanded

b. Code 2

(1) Convolutional, non-systematic, transparent

(2) Rate 1/2, constraint length 7

(3) Generator functions
G1 = 1011011
G2 = 1111001

(4) Symbols generated from G1 shall precede symbols generated from G2 relative to the data bit period.

(5) Symbols generated from G1 shall be complemented.

c. Code 3

(1) Convolutional, non-systematic, transparent

(2) Rate 1/3, constraint length 7

(3) Generator functions
G1 = 1111001
G2 = 1011011
G3 = 1110101

(4) The sequence from the convolutional coding shall be symbols generated to form G1, G2 and G3 successively relative to the data bit period.

(5) Alternate symbols shall be complemented.

d. Code 4

(1) Convolutional, non-systematic, non-transparent

(2) Rate 1/3, constraint length 7

(3) Generator functions:
G1 = 1111001
G2 = 1011011
G3 = 1100101

(4) Symbol sequence from the convolutional coding shall be symbols generated from G1, G2 and G3 successively relative to the data bit period.

APPENDIX II

20.0 NOT USED

APPENDIX III

30.0 TRACEABILITY MATRIX

30.1 SCOPE
This appendix provides a matrix that traces unit level requirements from this specification, 7472106, to requirements given in General Electric Corporation Hardware Configuration Item (HWCI) Specification, GES-STGT-1323, -1325, and -1328. The unit is required to satisfy, as a minimum, the requirements of these specifications for an Integrated Receiver.

30.2 TRACEABILITY

30.2.1 Direct Traceability
All Integrated Receiver requirements in 7472106 shall be traceable to the reference GE HWCI specifications, either directly, or through a set of logically derived requirements.

30.2.2 Single Configuration Item
The Integrated Receiver constitutes a single configuration item and may be used interchangeably in the K-Band Single Access Low Data Rate Equipment, S-Band Single Access Equipment, or Multiple Access Receiver/Transmit Equipment of the User Services Subsystem (USS) in the Second TDRSS Ground Terminal. As such, each GE HWCI requirement is satisfied by the unit, but not each unit requirement traces back to all of the HWCI specifications, since not all of these configuration items require all of the unit's capabilities.

30.3 THE MATRIX
The traceability matrix is presented in the following table.

INTEGRATED RECEIVER TRACEABILITY MATRIX

GE, HWCI Paragraph	SSA, KSA MA	Title	IEC, PERF SPEC Paragraph
3.1	S,K,M	Hardware Configuration Item Definition	N/A
3.1.1	S,K,M	Item Functions	N/A
3.1.1.1	S,K,M	Integrated Receiver (Article makes forward reference to GE 3.2.1.1.1.3)	Traced to GE 3.2.1.1.1.3
3.1.2	S,K,M	Major Equipment List	N/A
3.1.3	S,K,M	Interface Definition and Characteristics	N/A
3.1.3.1	S,K,M	Integrated Receiver	N/A
3.1.3.1.1	S,K,M	External Interfaces	N/A
3.1.3.1.1.1	S,K,M	AC Power	3.1.2.1
3.1.3.1.1.2	S,K,M	1553B Data Bus	3.1.2.2
3.1.3.1.1.3	S,K,M	Common Time and Frequency Inputs	3.1.2.3 3.1.2.3.1 3.1.2.3.2 3.1.2.3.3 3.1.2.3.4 3.1.2.3.5
3.1.3.1.1.4	S,K	370 MHz IF Input	3.1.2.4
3.1.3.1.1.5	K,M	Modulated 8.5 MHz IF	3.1.2.5
3.1.3.1.1.6	S,K,M	Low Data Rate Baseband Data/Clock Outputs	3.1.2.6
3.1.3.1.1.7	M	Recovered PN Code Outputs	3.1.2.7
3.1.3.1.1.8	K	Autotrack Outputs	3.1.2.8
3.1.3.1.1.9	S	Combining Baseband Data Inputs/Outputs	3.1.2.9
3.2	S,K,M	Characteristics	N/A
3.2.1	S,K,M	Performance Characteristics	N/A
3.2.1.1	S,K,M	Intregrated Receiver	N/A
3.2.1.1.1	S,K,M	IR Operations and Functions	N/A
3.2.1.1.1.1	S,K,M	Commanding	N/A
3.2.1.1.1.1.1	S,K,M	Configuration Commands	3.1.2.2.1.2
3.2.1.1.1.1.2	S,K,M	Reconfiguration	3.1.2.2.7
3.2.1.1.1.1.2.1	S,K,M	Recovery Reconfiguration	3.1.2.2.7.1
3.2.1.1.1.1.2.2	S,K,M	Restart Reconfiguration	3.1.2.2.7.2
3.2.1.1.1.1.3	S,K,M	Frequency and Delay Profile	N/A
3.2.1.1.1.1.4	S,K,M	IR Control Commands	APPENDIX II
3.2.1.1.1.2	S,K,M	Operating States	3.1.2.2.2
3.2.1.1.1.3	S,K,M	IR Functions	3.1
3.2.1.1.2	S,K,M	IR Performance	N/A
3.2.1.1.2.1	S,K,M	Input Signal Description	3.2.1.1.1 3.2.1.1.2.7,8
3.2.1.1.2.1.1	S,K,M	Interference	3.2.1.1.2.7
3.2.1.1.2.1.2	S,K,M	Input Data Configuration	3.2.1.1.2
3.2.1.1.2.1.3	S,K,M	P/N Coding	3.2.1.1.2
3.2.1.1.2.1.4	S,K,M	Input Error Correction Coding	3.2.1.1.2
3.2.1.1.2.1.5	S	Interleaving	3.2.1.4.7
3.2.1.1.2.1.6	S,K,M	(Not Used)	N/A
3.2.1.1.2.1.7	S,K,M	Data Accuracy	3.2.1.1.2.2
3.2.1.1.2.1.8	S,K,M	I:Q Power Ratio Accuracy	3.2.1.1.2.3
3.2.1.1.2.1.9	S,K,M	Symbol Transition Density	3.2.1.1.2.4
3.2.1.1.2.1.10	S,K,M	Symbol (Data) Jitter and Jitter Rate	3.2.1.1.2.5
3.2.1.1.2.1.11		C/No Dynamic Range and Variation	N/A
3.2.1.1.2.1.11.1	S	SSAR Services	3.2.1.1.2.1.3a,b
	K	KSAR Services	3.2.1.1.2.1.3f,b
	M	MAR DG-1 Services	3.2.1.1.2.1.3a,b

Integrated Receiver Traceability Matrix (Continued)

GE, HWCI Paragraph	SSA, KSA MA	Title	IEC, PERF SPEC Paragraph
3.2.1.1.2.1.11.2	S	SSHR Modes 1 and 2	3.2.1.1.2.1.3c
	K	KSHR Mode 1	3.2.1.1.2.1.3g,b
	M	MAR Calibration	3.2.1.1.2.1.3e
3.2.1.1.2.1.11.3	S	SSHR Mode 3	3.2.1.1.2.1.3c
	K	KSHR Mode 2 Subcarrier	3.2.1.1.2.1.3h,b
	M	MA Range Zero Set	3.2.1.1.2.1.3d(3)
3.2.1.1.2.1.11.4	S,K	Range Zero Set	3.2.1.1.2.1.3d(1),(2)
3.2.1.1.2.1.12	K	Autotrack Signal	3.2.1.1.2.9
3.2.1.1.2.1.13	S,K,M	Input Signal Distortions	3.2.1.1.2.6
3.2.1.1.2.1.14	S,K,M	Predicted User Ephemeris Information	3.2.1.1.3
3.2.1.1.2.1.14.1	S,K,M	Coherent (Two-Way) Services	3.2.1.1.3.1
3.2.1.1.2.1.14.1.1	S,K,M	MDP Commands	3.2.1.1.3.1.1
3.2.1.1.2.1.14.1.2	S,K,M	Delay Profile	3.2.1.1.3.1.2
3.2.1.1.2.1.14.1.3	S,K,M	Frequency Profile	3.2.1.1.3.1.3
3.2.1.1.2.1.14.1.4	S,K,M	TDRS Doppler Profile	3.2.1.1.3.1.4
3.2.1.1.2.1.14.2	S,K,M	Non-Coherent (One-Way) Services	3.2.1.1.3.2
3.2.1.1.2.1.14.2.1	S,K,M	MDP Commands	3.2.1.1.3.2.1
3.2.1.1.2.1.14.2.2	S,K,M	Delay Profile	3.2.1.1.3.2.2
3.2.1.1.2.1.14.2.3	S,K,M	Frequency Profile	3.2.1.1.3.2.3
3.2.1.1.2.1.14.2.4	S,K,M	TDRS Doppler Profile	3.2.1.1.3.2.4
3.2.1.1.2.1.14.3	M	Calibration Service	10.2.1.3.4
3.2.1.1.2.2	S,K,M	PN Code and Carrier Acquisition	N/A
3.2.1.1.2.2.1	S,K,M	Initial Acquisition	3.2.1.2.1a,b,c
3.2.1.1.2.2.2	S,K,M	Commanded New Acquisition	3.2.1.2.1d
3.2.1.1.2.2.3	S,K,M	Expanded Search	3.2.1.2.1e
3.2.1.1.2.3	S,K,M	Cycle Slippage	3.2.1.4.1.1
3.2.1.1.2.4	S,K,M	False Acquisition	3.2.1.2.2
3.2.1.1.2.5	S,K,M	Reacquisition	3.2.1.2.3
3.2.1.1.2.6	S,K,M	Probability of Error	N/A
3.2.1.1.2.6.1	S,K,M	Definitions	N/A
3.2.1.1.2.6.1.1	S,K,M	Minimum Required Channel Carrier-to-Noise Density Ratio	3.2.1.1.2.1.2a
3.2.1.1.2.6.1.2	S,K,M	Minimum Required Total Carrier-to-Noise Density Ratio	3.2.1.1.2.1.2c,d,e
3.2.1.1.2.6.2	S,K,M	Requirements	N/A
3.2.1.1.2.6.2.1	S,K,M	Bit Error Probability	3.2.1.1.2.1.2
3.2.1.1.2.6.2.2	S,K,M	Applicability	3.2.1.1.2.1.2
3.2.1.1.2.6.2.3	S	Decoder Bypass	3.2.1.3.6
3.2.1.1.2.7	S,K,M	Ambiguity Resolution	3.2.1.4.2.1 3.2.1.4.2.2 3.2.1.4.2.2.1 3.2.1.4.2.3
3.2.1.1.2.8	S	Symbol Synchronization (Decoder Bypass)	3.2.1.3.4
	K	Symbol Synchronization (Uncoded Data Only)	3.2.1.3.1
3.2.1.1.2.9	S,K,M	Symbol/Decoder Synchronization (Non-Interleaved, Coded Data Only)	3.2.1.3.2 3.2.1.3.2.1 3.2.1.3
3.2.1.1.2.10	S	Symbol/Deinterleaver/Decoder Synchronization (Coded and Interleaved Data Only)	3.2.1.3 3.2.1.3.3
3.2.1.1.2.11	S,K,M	Bit Slippage	3.2.1.4.1.2

Integrated Receiver Traceability Matrix (Continued)

GE, HWCI Paragraph	SSA, KSA MA	Title	IEC, PERF SPEC Paragraph
3.2.1.1.2.12	S,K,M	Loss of Symbol Synchronizer	3.2.1.4.1.2
3.2.1.1.2.13	S	Dynamic Tracking	3.2.1.4.1.3
3.2.1.1.2.14	S	SSAR Combining	3.1.2.9, 3.2.1.4.3
3.2.1.1.2.15	K	Autotrack Signal Processing	3.2.1.4.4
3.2.1.1.2.16	S,K,M	Data Processing Delay	3.2.1.4.5
3.2.1.1.2.17	S,K,M	Channel Error Rate Estimate	3.2.1.4.6
3.2.1.1.2.18	S,K,M	Channel Lock Time Measurement	3.2.1.3.5
3.2.1.1.2.19	S,K,M	Frequency and Delay Profile	3.2.1.1.3.1.5
3.2.1.1.2.20	S,K,M	Forward Model	3.2.1.1.3.1.1 3.2.1.1.3.2.1 3.1.2.2.4
3.2.1.1.2.21	M	Recovered PN Code Output	3.1.2.7
3.2.1.1.3	S,K,M	Tracking Services	N/A
3.2.1.1.3.1	S,K,M	Range Delay Measurement	N/A
3.2.1.1.3.1.1	S,K,M	Description	3.2.1.5.1.1
3.2.1.1.3.1.2	S,K,M	Services	3.2.1.5.1
3.2.1.1.3.1.3	S,K,M	Random Error	3.2.1.5.1.2 3.2.1.5.1.2.1
3.2.1.1.3.1.4	S,K,M	Systematic Error	3.2.1.5.1.3
3.2.1.1.3.1.5	S,K,M	Reporting	3.2.1.5.1.4
3.2.1.1.3.2	S,K,M	Doppler Measurement	N/A
3.2.1.1.3.2.1	S,K,M	Description	3.2.1.5.2.1
3.2.1.1.3.2.2	S,K,M	Services	3.2.1.5.2
3.2.1.1.3.2.3	S,K,M	Measurement Error	3.2.1.5.2.2
3.2.1.1.3.2.4	S,K,M	Doppler Count Capacity	3.2.1.5.2.3
3.2.1.1.3.2.5	S,K,M	Doppler Count Reset	3.2.1.5.2.4
3.2.1.1.3.2.6	S,K,M	Reporting	3.2.1.5.2.5
3.2.1.1.3.3	S,K,M	Time Transfer Measurement	N/A
3.2.1.1.3.3.1	S,K,M	Receiver Epoch Time Definition	3.2.1.5.3
3.2.1.1.3.3.2	S,K,M	Services	3.2.1.5.3
3.2.1.1.3.3.3	S,K,M	Random Error	3.2.1.5.3a
3.2.1.1.3.3.4	S,K,M	Systematic Error	3.2.1.6.5b
3.2.1.1.3.3.4.1	S,K,M	Reporting	3.2.1.5.3c
3.2.1.1.4	S,K,M	Performance Measuring and Monitoring Support	3.1.2.10.1-2
3.2.1.1.4.a	SSA, KSA, MA	On-line and Extended Bit	3.2.1.6.1, 3.2.1.6.1.1, 3.2.1.6.1.2
3.2.1.1.4.b	SSA, KSA, MA	Status Reporting	3.1.2.2
3.2.1.1.4.c	SSA, KSA, MA	Front Panel Capabilities	3.1.2.10.1.a, 3.1.2.10.2, 3.1.2.10.3.a
3.2.1.1.4.d	SSA, KSA, MA	Local/Remote	3.1.2.10.1.c
3.2.2	S,K,M	Physical Characteristics	3.2.2
3.2.2.1	S,K,M	Size	3.2.2.1
3.2.2.2	S,K,M	Weight	3.2.2.2
3.2.2.3	S,K,M	Packaging	3.2.2
3.2.2.3.1	S,K,M	Rack Packaging	N/A
3.2.2.3.2	S,K,M	Chassis Packaging	3.2.2.1 3.3.1.5 3.2.2, 3.3.3

Integrated Receiver Traceability Matrix (Continued)

GE, HWCI Paragraph	SSA, KSA MA	Title	IEC, PERF SPEC Paragraph
3.2.2.4	S,K,M	Cabling	N/A
3.2.2.5	S,K,M	Cooling	N/A
3.2.2.6	S,K,M	Acoustical Noise	3.2.3.3
3.2.3	S,K,M	Reliability	3.2.3
3.2.3.1	S,K,M	Mean Time Between Failures (MTBF)	3.2.3.1
3.2.3.2	S,K,M	Design Life	3.2.3.2
3.2.3.3	S,K,M	Operational Capability	N/A
3.2.4	S,K,M	Maintainability	3.2.4
3.2.4.1	S,K,M	Line Replaceable Unit (LRU) Replacement	3.2.4.1
3.2.4.1.1	S,K,M	LRU Definition	3.2.4.1.1
3.2.4.2	S,K,M	Mean Time to Repair (MTTR)	3.2.4.2
3.2.4.3	S,K,M	Maximum Time to Repair (MTR)	3.2.4.3
3.2.4.4	S,K,M	Self Test	3.2.1.6.1
3.2.4.4.1	S,K,M	Confidence Test	3.2.1.6.2.1
3.2.4.4.2	S,K,M	Operational Test	3.2.1.6
3.2.4.4.3	S,K,M	Isolation of a Malfunction	3.5.1.3, 3.5.1.2 & 3.5.1.3.1
3.2.4.4.4	S,K,M	Fault Isolation Performance Requirements	N/A
3.2.4.4.5		Test Via Standard Commercial Test Equipment	3.5.1.3
3.2.4.4.6	S,K,M	Fault Isolation Using Extended Bit	3.2.1.6.1.2.2
3.2.4.5	S,K,M	Maintainability Demonstration	N/A
3.2.5	S,K,M	Environmental Conditions	3.2.5
3.2.5.1	S,K,M	Non-Operating-Shipping and Storage	3.2.5.1
3.2.5.1.1	S,K,M	Temperature	3.2.5.1.a
3.2.5.1.2	S,K,M	Humidity	3.2.5.1.b
3.2.5.1.3	S,K,M	Altitude	3.2.5.1.c
3.2.5.1.4	S,K,M	Solar Radiation	3.5.5.1.d
3.2.5.2	S,K,M	Operating - Environmentally Controlled Area	3.2.5.2
3.2.5.2.1	S,K,M	Temperature	3.2.5.2.a
3.2.5.2.2	S,K,M	Humidity	3.2.5.2.b
3.2.5.2.3	S,K,M	Altitude	3.2.5.2.c
3.2.6	S,K,M	Transportability	3.2.6
3.3	S,K,M	Design and Construction	3.3
3.3.1	S,K,M	Parts, Material and Processes	3.3.1
3.3.1.1	S,K,M	Standard and Non-Standard Parts and Materials	3.3.1.2
3.3.1.1.1	S,K,M	Standard Parts and Material	3.3.1.2.1
3.3.1.1.2	S,K,M	Non-Standard Parts and Materials	3.3.1.2.2
3.3.1.1.3	S,K,M	Programming and Handling of Semiconductor Devices	3.3.1.2.4
3.3.1.2	S,K,M	Standard Components	3.3.1.2.3
3.3.2	S,K,M	Electrical Design	N/A
3.3.2.1	S,K,M	Electrical Connections	N/A
3.3.2.1.1	S,K,M	Attachment of Wires and Leads	3.3.1.7.1.1
3.3.2.1.22	S,K,M	Solderless Wrap	3.3.1.7.1.2
3.3.2.1.3	S,K,M	Soldered Connections	3.3.1.7.1.3
3.3.2.2	S,K,M	Electrical/Electronic Parts	3.3.1.7.2
3.3.2.3	S,K,M	Electrical Power	3.3.1.7.3
3.3.2.3.1	S,K,M	Single-Phase Power	3.1.2.1 & 3.3.1.7.3.1 & 3.3.6.1
3.3.2.3.2	S,K,M	Power Cable Connections (Not applicable)	N/A
3.3.2.3.3	S,K,M	Power Transient Susceptibility	3.3.1.7.3.2

Integrated Receiver Traceability Matrix (Continued)

GE, HWCI Paragraph	SSA, KSA MA	Title	IEC, PERF SPEC Paragraph
3.3.2.3.4	S,K,M	Rack Mounted Chassis Power	N/A
3.3.2.3.5	S,K,M	Overload Protection	3.3.1.7.3.3
3.3.2.3.5.1	S,K,M	Primary Circuit Fuses	3.3.1.7.3.4
3.3.2.3.5.2	S,K,M	Circuit Breakers	3.3.1.7.3.5
3.3.2.3.6	S,K,M	Power Loss Reporting (Not applicable)	N/A
3.3.2.3.7	S,K,M	Batteries	N/A
3.3.2.4	S,K,M	Printed Wiring	3.3.1.7.4
3.3.2.4.1	S,K,M	Single or Double Sided Printed Wiring Boards	3.3.1.7.5
3.3.2.4.2	S,K,M	Multilayer Printed Wiring Boards	3.3.1.7.6
3.3.2.5	S,K,M	Preferred Circuits	3.3.1.7.7
3.3.2.6	S,K,M	ARC Suppression	N/A
3.3.3	S,K,M	Mechanical Design	N/A
3.3.3.1	S,K,M	Accessibility	3.3.1.8.1
3.3.3.2	S,K,M	Structural Integrity	3.3.1.8.2
3.3.3.3	S,K,M	Captive Hardware	3.3.1.8.3
3.3.3.4	S,K,M	Coating, Treatment and Painting	3.3.1.4 & 3.3.1.3
3.3.3.5	S,K,M	Thermal Design	3.3.2.10
3.3.3.6	S,K,M	Structural Welding (Not applicable)	N/A
3.3.4	S,K,M	Electromagnetic Compatibility (EMC) Control	3.3.2, 3.3.1.3
3.3.4.1	S,K,M	EMI Development Training	3.3.2.1
3.3.4.2	S,K,M	Commercial-Off-The-Shelf (COTS) Equipment	N/A
3.3.5	S,K,M	Grounding, Bonding and Shielding	3.3.1.5
3.3.6		Red/Black Isolation (Not applicable)	N/A
3.3.7	S,K,M	Identification and Marking	3.3.3, 3.3.6, & 3.3.1.6
3.3.8	S,K,M	Workmanship	3.3.4
3.3.9	S,K,M	Interchangeability/Producibility	N/A
3.3.9.1	S,K,M	Interchangeability	3.3.5.1
3.3.9.2	S,K,M	Producibility	3.3.5.2
3.3.10	S,K,M	Safety Criteria	3.3.6
3.3.10.1	S,K,M	Leakage Current	3.3.6.1
3.3.10.2	S,K,M	Power Supply Protection	3.3.6.2
3.3.10.3	S,K,M	Printed Circuit Assembly Protection	3.3.6.3.1
3.3.10.4	S,K,M	Equipment Electrical Power-ON-OFF Switch	3.3.6.3
3.3.10.5	S,K,M	Power Indicator Lamp	3.3.6.4
3.3.10.6	S,K,M	Electrical Cable Protection	3.3.6.5
3.3.10.7	S,K,M	Support Strength	3.3.6.6
3.3.10.8	S,K,M	Equipment Access Security	3.3.6.7
3.3.10.9	S,K,M	Critical Controls	3.3.6.8
3.3.10.10	S,K,M	Human Error Design Protection	3.3.6.9
3.3.10.11	S,K,M	Unacceptable Materials	3.3.6.10
3.3.10.12	S,K,M	Test Circuit Components	3.3.6.11
3.3.11a,b,c,d	S,K,M	Human Engineering	3.3.7
3.3.11.e	S,K,M	Physical Keying	3.3.5.1.d
3.3.12	S,K,M	Standards of Manufacture	N/A
3.4	S,K,M	Documentation	N/A
3.5	S,K,M	Logistics	3.5
3.5.1	S,K,M	Maintenance Levels	N/A
3.5.1.1	S,K,M	On-Line Corrective Maintenance, First Level Maintenance	3.5.1.3

Integrated Receiver Traceability Matrix (Continued)

GE, HWCI Paragraph	SSA, KSA MA	Title	IEC, PERF SPEC Paragraph
3.5.1.1.1	S,K,M	Use of Maintenance Test Group	3.5.1.2
3.5.1.1.2	S,K,M	In-Circuit Preventive Maintenance, First Level Maintenance	3.5.1.3.2
3.5.1.2	S,K,M	Off-Line Maintenance, Second Level Maintenance	N/A
3.5.1.2.1	S,K,M	Hardware Maintenance Depot (HMD)	N/A
3.5.1.2.2	S,K,M	Vendor Maintenance	N/A
3.5.1.2.2.1	S,K,M	On-Line Equipment Resupply	N/A
3.5.1.2.2.2	S,K,M	Configuration Management	N/A
4.0	S,K,M	Quality Assurance Provisions	N/A
4.1	S,K,M	General	4.1
4.1.1	S,K,M	Responsibility for Verifications	4.1.1
4.1.1.1	S,K,M	Quality Assurance Requirements	4.1.1.1
4.2	S,K,M	Quality Conformance Requirements	4.2
4.2.1	S,K,M	Test	4.2.1
4.2.2	S,K,M	Inspections	4.4.2
4.2.3	S,K,M	Demonstration	4.2.3
4.2.4	S,K,M	Analysis	4.2.4
4.2.5	S,K,M	Method Annotation	4.2.5
5.0	S,K,M	Preparation for Delivery	Title
5.1	S,K,M	Preservation, Packing, & Marking	5.0

APPENDIX IV

40.0 TEST MATRIX

40.1 SCOPE

Reference IEC Document C901E3860.